



Evaluating and exploring the implementation of the Hydr8 system in care homes across the North East

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Glossary

App:	Application software.
CCG:	Clinical Commissioning Group.
Hydr8:	Application software developed as part of this project. The Hydr8 app was used to record hydration data.
Tablet:	A small portable computer that allows users to input data directly using touch-screen technology.

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1. Background

The issue

The catalyst for the “Hydr8” project was the findings of a joint commissioning quality review process undertaken by North Tyneside Clinical Commissioning Group and North Tyneside Local Authority in relation to the quality of commissioned services provided in North Tyneside nursing homes. The intended outcome of the review was to identify opportunities for ongoing quality improvement as well as celebrate and share areas of good practice. The review considered the following key areas within a wider holistic care home context of care:

- Nutrition and Hydration
- Pressure care management
- Falls Risk assessment
- Infection, Prevention and control
- Dementia care
- Continence Care
- End of Life Care
- Care Planning
- Supervision and Leadership
- Medicines Management
- Social Stimulation
- Environment

The review identified a number of common areas for improvement: Nutrition and Hydration, Care Planning and Leadership, and Productive Working.

The management of hydration was an area identified for improvement and while all care homes had policies relating to hydration, how these translated into practice varied significantly. A main area of concern related to vulnerable clients requiring fluid balance monitoring (recording of fluid intake and sometimes also output via charts). Although there were examples of good practice, in some cases these clients were poorly managed. Completion of fluid balance charts was often inconsistent and despite many charts having clear instructions outlining the amount of fluid a resident required, recordings often did not collate with amounts of fluid consumed and resident preferences. Information from the charts showing trends over a period of days was not readily accessible to the nurses and carers on duty. Therefore, the focus tended to be on the day in question rather than consideration being given to cumulative total intake over a few days.

Communication of this core information between staff (including nurses on duty and care assistants) varied. It is important to highlight that in many care homes there is generally only one registered nurse on duty at any time with the majority of care delivery being provided by the non -professionally registered, but often highly skilled, care staff. The outcomes of the review were triangulated with serious incident information, Care Quality Commission reviews and adult safeguarding alerts. One patient with dementia, who had been admitted into a home for respite, died following admission to hospital from the nursing home with severe dehydration being identified as a contributory factor.

Hospital admissions from Nursing Homes within the North Tyneside Clinical Commissioning Group (CCG) area account for many of the elderly admissions which take place. Admissions for dehydration and gastroenteritis over the last 12 months showed that 34% are over 65 and 26% are over 75, not including those patients with urinary symptoms and other associated conditions. Subsequent process mapping identified that working processes in the majority of the homes, did little to free up staff time allowing them to provide direct care. Given the norm is only one registered nurse on duty at a time, it is clear that anything which could help ensure core information on each patient is communicated effectively and efficiently is of value.

Findings from the joint commissioning quality review process were shared at feedback sessions with representatives from all of the care homes involved. Attendees were not surprised by the findings and concurred with the priority areas identified. Some immediate changes related to the delivery of safe care were made in the homes at the time of review, however it was recognised that a more productive way of working was required in relation to hydration management in the longer term.

Solution seeking

A bid was submitted to the Academic Health Science Network for North East and North Cumbria detailing the findings and proposing a joint health, social care and industry venture as a way of responding to this crucial area of care. The bid was supported by the respective care home Directors/ Chief Executives. Support from the Academic Health Science Network was secured due to the strategic fit of the “Hydr8” project with a core area of activity around ‘aging well’; the projects promotion of health and wellbeing and person centred care in nursing homes; and the potential of the project to be expanded into peoples’ own homes where they receive domiciliary care. Other favourable features included the partnership approach proposed and outcomes including improvements both in standards of care and in workforce knowledge and skills.

The Hydr8 project is a collaboration between North Tyneside CCG and ‘Nine’ a business providing technical expertise, with the nursing homes and their staff in pilot areas as key collaborators throughout. This collaboration intended to co-design a technical solution to a human factor problem and provided opportunities to use tried and tested industry products and adapt them for use with NHS providers for the benefit of patients. The project aimed to improve standards of care and therefore health, as well as increasing the knowledge of the care home staff in relation to the importance of hydration. It was also felt such a solution would improve the quality of information accessible by care home staff, the CCG and primary care clinicians.

What Hydr8 is

Hydr8 has two core parts: the back office ‘solution’ accessed via a web browser, and mobile device (for the mobile Application ‘App’).

The Hydr8 'solution' aimed to:

- Raise awareness of the importance of ensuring that nursing home residents are adequately hydrated.
- Facilitate accurate completion and communication of fluid balance status for all identified residents.
- Facilitate accurate monitoring of the number of residents receiving sub cutaneous fluids.
- Automate the recording of fluid balance maximising the use of accessible technology.
- Enable care home staff to see the cumulative totals for each patient at a glance and be alerted when residents appear to be falling behind optimum levels.
- Enable GP/ named clinician to access real-time information on residents.

And over time:

- Reduce hospital admissions with dehydration from nursing homes.
- Release time of nursing home staff to care and lead.
- Reduce the number of audits that care home staff have to undertake.
- Demonstrate a tried and tested process for the development of other mobile clinical metrics including, vital signs, pressure ulcers, fall risks.
- Demonstrate the benefits of using technology in nursing home settings in the form of web delivered solutions with mobile application devices.

The actual time released to care and lead may be defined in the future when baseline process mapping has been completed in all of the homes and is compared with a fully functioning Hydr8 system used in practice.

The Evaluation

As part of the Hydr8 project an evaluation study was undertaken which aimed to investigate both the collaborative development of the 'solution' and its implementation in pilot care homes in North Tyneside.

The evaluation had three objectives:

1. To review the literature (past 5 years) in order to develop an understanding of the state of knowledge in the areas of: hydration measurement and monitoring for older people and care home residents, and to inform data collection, analysis and theorising.
2. To explore the development of the system in relation to:

- The acceptability of collaborative working between commissioners, providers and industry to co-design a technical solution to a human factor problem.
3. To describe, explore and evaluate the implementation of the system into a small number of pilot sites in relation to:
- The process of implementation and operationalization
 - Embedding and normalisation of the system as part of everyday practice
 - The impact on care provision and outcomes
 - Education, development and training needs of staff

This report will be subsequently divided into three main sections, each reflecting the objectives of the project.

2. Objective 1: The Literature review

A narrative review of works published during the preceding ten years was conducted at the outset of the project in order to set the study in context and understand contemporary knowledge of hydration measurement and monitoring for older people and care home residents. The results from this literature review also informed the data collection, analysis and theorising as part of objectives two and three.

Methods

A literature search was performed using the databases listed in Table 1 for the period 2004-2014.

Table 1 Databases

Database	References retrieved
CINAHL	40
Medline	35
Scopus	142
Hospital Collection	132
Web of Science	118
ASSIA	18
TOTAL	485

Subject headings and title or abstract key words used in the searches were: dehydration, hydration, fluid balance, fluid imbalance, fluid-electrolyte balance in old age, water-electrolyte balance, nursing home(s), care home(s), nursing home patients. Searches were limited to scholarly/peer-reviewed articles readily available in the English language. A total of 485 references were downloaded into an EndNote Library, 161 duplicates removed, and the remaining 324 references (abstracts) screened according to the inclusion criteria derived from a SPICE framework as shown in Table 2.

Table 2 SPICE framework used to indicate inclusion criteria

SPICE framework	
Setting	Care homes, residential homes, long-term care facilities, not palliative care
Population	Elderly residents, clients, 65 years+
Intervention	Concerning daily practice and processes re hydration
Comparison	Not essential
Evaluation	May be in the form of impact/outcome measures, recommendations for and changes in practice

There were 278 references excluded because, for example, the setting or population was out of scope or there was no intervention. Interventions to promote nutrition and hydration tended to focus on nutrition rather than oral rehydration and were excluded as were references concerned with artificial hydration, subcutaneous hydration, continence etc. The summary document draws from the full text of the remaining 46 papers. In addition, a secondary search was performed of three open access resources, NHS Evidence, the

Cochrane Library and the Social Care Institute for Excellence website. One extra article was identified. Table 3 summarises the identification, screening, eligibility, and inclusion flow.

Table 3 Identification, screening, eligibility, inclusion flow (PRISMA)

Stage	Number of records
Records identified through database searching	485
Records after duplicates removed	324
Records screened at abstract level	324
Records excluded	278
Full-text articles included in summary	46
Additional records identified through other sources	1

Findings

Introduction

A hydration management evidence-based protocol was developed by Mendes in 2000 to help health care providers in all settings determine adequate oral fluid intake for elderly individuals and to use strategies that will maintain hydration. The protocol offers background information on individuals likely to be at risk for hydration management problems, assessment tips, and strategies for interventions.

In 2003 a systematic review (Hodgkinson, Evans and Wood, 2003) of oral hydration in older adults revealed no clear determination of the risk factors for dehydration and decreased fluid intake and concluded that more research was required to determine the optimum method of maintaining adequate oral hydration in older adults. The review identified that the recommended daily intake of fluids should be not less than 1600 mL/24 h in order to ensure adequate hydration; a fluid intake sheet and urine specific gravity might be the best methods of monitoring daily fluid intake; and regular presentation of fluids to bedridden older adults can maintain adequate hydration status.

In Scotland a Care Commission report (The Care Commission, 2009), *Eating well in care homes for older people*, describes a complex scenario of conflicting evidence concerning hydration. Whilst the inspection revealed that 66% of care homes screened people for the risk of dehydration when they first came to the care home and 85% of services had personal plans which identified care for every person 'at risk' of dehydration, these positive findings differed from complaint investigation findings. The largest number of complaints concerned people's dietary needs not being met, in particular not providing enough fluids. 52 of the 164 concerns investigated were about dehydration provoking concern that people were not being offered drinks, and/or encouraged to drink regularly. Examples cited include drinks left out of reach, confusion about who was responsible for offering cold drinks to people, personal plans not in place to make sure people at risk of dehydration were given enough to drink, and care home staff being slow in starting fluid charts, not keeping them up to date and not acting on the results.

In 2011 the Care Quality Commission (CQC) published reports from the Dignity and Nutrition inspection programme <http://www.cqc.org.uk/file/4909> that examined whether elderly people

were receiving essential standards of care in 100 hospitals throughout England. One of the major concerns raised was that people were not being given enough to drink. Water was being left out of reach or no fluids were given for long periods of time. In one case, a member of clinical staff described having to prescribe water on medicine charts to ensure patients got enough to drink. Ashcroft describes what nurses and care staff can do to ensure their residents have enough, for example, nurses should record food and drink likes and dislikes in individuals' care plans, snack options to include fresh fruit and nourishing smoothie-type drinks, when drinks are served to older people, staff should always ensure that every resident is able to reach their drink, residents must be provided with refreshing drinks 24 hours a day, ideally from plumbed-in water coolers located throughout the home and so on.

Over a decade after the findings from the systematic review by Hodgkinson, Evans and Wood (2003), more recent studies in the UK continue to provide insight into the factors that promote adequate hydration and the barriers which prevent older people from drinking. However, it would appear that the issues are still not well understood. Figures obtained by The Daily Telegraph newspaper (Riley-Smith, 2013) under freedom of information laws found that 1,158 care home residents suffered dehydration-related deaths between 2003 and 2012. Dehydration was named as either the underlying cause of death or a contributory factor, according to analysis of death certificates by the Office of National Statistics.

Guidance

A survey of water provision in UK care homes for older people in October 2003 found that at best most residents only consumed 2 to 4 glasses (480-960ml) a day (Water UK, 2003). A conservative estimate for adults is that daily intake of fluids should not be less than 1.6 litres per day. The introduction of Care Standards at that time recognised the clear benefits of hydration to residents in care homes and the role that carers play in supporting older, more dependent individuals in maintaining healthy levels of hydration. Carers can do this by ensuring that fresh tap water is made freely available and physically accessible day and night, as well as with meals, by being aware of an individual's need for water and by encouraging all residents to drink enough. In 2005 Water UK produced *Water for healthy ageing: hydration best practice toolkit for care homes*. This was revised by the Royal College of Nursing and the National Patient Safety Agency in 2007 to produce *Water for Health: Hydration Best Practice Toolkit for Hospitals and Healthcare*.

Ashurst (2011) highlights the need for care home staff to be made aware of the impact that food and drink has on the well-being of older people and notes that educating staff is essential to promoting the presentation of quality drinks for older people. Professional guidelines are available to aid this process. More recently Shepherd (2013) provided practical guidance that can support care home staff and multidisciplinary teams to prevent, identify and treat dehydration.

Research evidence

Of the 47 papers referred to in this review 25 are research studies (

). An examination of the methodologies and data collection types using the terminology featured in the papers themselves revealed a very wide range. Using general categories, eleven studies are best described as descriptive. Six studies considered the tools and

processes of hydration through comparison and evaluation. There were three clinical studies, three social intervention studies and two mixed methods case studies.

A cross-sectional descriptive study by Abdallah, Remington, Houde, Zhan, & Melillo (2009) used survey findings and focus group interviews to investigate dehydration problems among community-dwelling older adults and to identify strategies perceived to be helpful in preventing dehydration in this population. The survey sample (n = 18) and four focus groups (n = 36) included health care providers in the northeast United States from provider agencies representing emergency care, home care, primary care, and community health care. Four major themes emerged: Intentional Avoidance and Caution, Lack of Awareness/Education/Understanding, Poor Access to Fluids, and Social and Environmental Influences. Strategies identified to promote hydration in community-dwelling older adults included community partnerships, community education, community engagement, and interdisciplinary approaches. This study provides useful information and detailed strategies recommended by health care providers for designing interventions to promote hydration for community-dwelling older adults.

An evaluation of changes in food and drink provision of 120 older people living in six care homes in Norfolk (Kenkmann, Price, Bolton, & Hooper, 2010) explored whether a pragmatic methodology, including routinely collected data, was feasible to describe the health, wellbeing and nutritional status of care home residents and assess effects of changed provision of food and drink on residents' falls (primary outcome), anaemia, weight, dehydration, cognitive status, depression, lipids and satisfaction with food and drink provision. The intervention was implemented in three care homes and comprised an improved dining atmosphere, greater food choice, extended restaurant hours, and readily available snacks and drinks machines. Three control homes maintained their previous system. Outcomes were assessed in the year before and the year after the changes. The results show that use of routinely collected data was partially successful, but loss to follow up and levels of missing data were high, limiting power to identify trends in the data. The authors conclude that the intervention to improve food and drink provision was well received by residents, but effects on health indicators (despite the relative reduction in falls rate) were inconclusive, partly due to problems with routine data collection, loss to follow up and the fact that such care home residents are frail and experience multiple health risks.

Even where the provision of food and fluids within care homes meets guidance, residents tended to consume significantly less than what was provided and this is one example of how deficiencies may arise. For example, Cunneen, Jones, Davidson & Bannerman (2011) describes a cross-sectional observational study carried out in one Scottish care home to assess food and fluid provision and consumption among 25 private long-term care home residents (mean age 86 years) and also identify the contribution different eating occasions make to food intakes. Dietary intake of each participant was recorded and analysed for a 24-hour period using plate-wastage methodology. All foods and fluids throughout the day were weighed using calibrated scales both before foods were served to residents and any leftovers were weighed following consumption. Whilst there was no significant difference between energy provided compared with recommended provision, significantly less energy than recommended was consumed. Interestingly more than 95% of snacks provided were consumed, and as a result these contributed an equivalent proportion to overall energy intake as breakfast and lunch, but these were not rich in protein.

Clients with dementia appear to be a particularly vulnerable group with two studies showing that approximately half of those studied had low fluid intake. For example, a four-month cross-sectional study of 111 elderly residents in Taiwan (Wu, Wang, Yeh, Wang & Yang, 2011) to investigate fluid intake and dehydration found that the average daily fluid intake of the residents was 2083mL and 45% had a daily fluid intake that was less than their estimated requirements. The authors identified mode of feeding and a diagnosis of dementia as significant predictors of daily fluid intake. Earlier research by Reed, Zimmerman, Sloane, Williams & Boustani (2005) describes the prevalence, assessment, and treatment of, as well as characteristics associated with, the food and fluid intake of 407 residents with dementia in 45 assisted living facilities and nursing homes. In this study, 54% of observed residents had low food intake, and 51% had low fluid intake. The authors suggest that staff monitoring of residents, having meals in a public dining area, and the presence of non-institutional features were each associated with higher food and fluid intake.

A qualitative study by Godfrey, Cloete, Dymond & Long (2012) aimed to understand the complexity of issues associated with the hydration and hydration care of older people in two sites providing care for older people in the South West of England: a hospital ward in a major hospital and a care home providing personal and nursing care. Study participants from the hospital ward and the care home together included 21 older people aged 68-96 years; 21 staff, nurses and health care assistants, who provided hydration care and 7 friends/relatives who participated by making anonymous comments via a suggestion box. Data were collected via interviews with older people, focus group discussions involving staff, suggestion box comments and 12 hours' observation of hydration practice. The thematic analysis reveals that health professionals successfully employed several strategies to promote drinking including verbal prompting, offering choice, placing drinks in older people's hands and assisting with drinking. In parallel, older people revealed their experience of drinking was diminished by a variety of factors including a limited aesthetic experience and a focus on fluid consumption rather than on drinking as a pleasurable and social experience. The study concludes that "the rich and varied dimensions usually associated with drinking were lacking and the role of drinking beverages to promote social interaction was underplayed in both settings."

In a review of water-loss dehydration and aging Hooper, Bunn, Jimoh and Faiweather-Tait (2014) specifically identify strategies to increase fluid intake in residential care homes, for example, identifying and overcoming individual and institutional barriers to drinking, such as being worried about not reaching the toilet in time, physical inability to make or to reach drinks, and reduced social drinking and drinking pleasure. The review identifies that in older adults, lower muscle mass, reduced kidney function, physical and cognitive disabilities, blunted thirst, and polypharmacy all increase dehydration risk (Hooper *et al.*, 2014). However, they found that clear signs of early dehydration had still not been developed and that whilst water-loss dehydration is associated with higher mortality, morbidity and disability in older people, evidence is still needed that this relationship is causal.

Examples of innovative practice

In 2003 Mentes and Culp used a quasi-experimental treatment and control group design with 49 participants from four nursing homes to test the effectiveness of an 8-week hydration intervention in reducing hydration-linked events. Although there were no statistically

significant differences between the groups, it is clinically significant that the frailer, more at-risk participants in the treatment group had a lower incidence of hydration-linked events.

Sullivan (2005) described how the staff at Universal Healthcare and Rehabilitation Centre in Concord, North Carolina use a 'nourishment cart' covered with a decorative canopy as part of their hydration program. "The dietary staff stock the cooler on the cart with various juices and milk, plus a variety of snacks including gelatine, ice cream, and pudding, which can also contribute to the total liquid intake of the residents. The cart is pushed from room to room, and beverages and snacks are offered at mid-morning, mid-afternoon, and in the late evening. The afternoon hydration and nourishment pass at Taylor Extended Care Facility in Sealevel, North Carolina is part of the activity program. The cart is decorated with balloons and has music playing while the staff pushes it through the halls in the mid-afternoon. The staff offers snacks to the residents from the cart, which may consist of ice cream, soft drinks, or juices. The snacks and the music are often coordinated to coincide with the planned activity in the facility that day. The activity staff report that the residents often come into the hallway in the afternoon when they hear the music, and they look forward to receiving a beverage and snack."

In 2005, Ferry identified strategies for ensuring good hydration in the elderly in the community setting. These practical approaches included frequent encouragement to drink, offering a wide variety of beverages, advising to drink often rather than large amounts, and by adaptation of the environment and medications as necessary. Ellins (2006) also usefully describes hydration best practice for older people including tips from carers.

Gleibs (2011) tested the idea of establishing water clubs in care homes to counteract the dangers of dehydration and enhance residents' health and well-being and also explored the possibility that it is the social interaction that clubs provide which delivers health-related benefits. This study found no evidence that, on its own, increased focus on water consumption enhanced residents' health or well-being. However, residents who took part in water clubs showed improved levels of perceived social support and beneficial outcomes in terms of the number of GP calls they required.

In relation to care planning and practice monitoring the process of audit and feedback can also contribute to improved practice. Keller (2006) measured current practice against best practice using a clinical audit tool and then consulted with key stakeholders to identify limitations to achieving best practice and plan action to address these limitations where possible. Keller found that this process was helpful and notes "while 100% compliance with all audit criteria was not achieved, strategies to improve current practice were identified and are in the process of being implemented." An essential component of a care plan is an individualized recommendation for water intake to facilitate goal setting. A comparison of four standards used to determine a recommended water intake among nursing home residents (Gaspar, 2011) identified inconsistencies and concluded that the standard based on height and weight provides the most individualized recommendation.

Alexander (2008) evaluated a clinical decision support system (CDSS) in three nursing homes. The CDSS included alerts for decline in condition, improvement in condition, constipation, dehydration, loss of skin integrity, weight loss, and weight gain. The most frequent alerts were for dehydration and improvement in condition.

Developing a bundle to improve fluid management and patient hydration in a range of settings McIntyre, et al. (2012) describe how a team from NHS East of England developed the Intelligent Fluid Management bundle to support practitioners in ensuring patients receive adequate hydration.

http://nhs.stopthepressure.co.uk/docs/Developing_a_bundle_to_improve_fluid_management.pdf

In practice monitoring of fluid intake is normally achieved by visual examination of drinking vessels conducted by staff members, i.e., estimations of filling levels. Kreutzer, et al. (2013) describes a measurement targeted at evaluating this method in order to analyse the requirements of technical aids. Data gained in an elderly people home shows that residents drink on average 5-10% less than is recorded and that estimations of especially partly filled vessels vary strongly. Both, the type of drinking vessel and the current filling level influence the accuracy and precision of the difference between estimation and actual missing liquid.

Research by Menten (2013) attempts to unpick the complexities of hydration issues in the elderly and suggests that identifying hydration habits can provide important information about an individual's hydration status and that in combination with biochemical indicators of hydration may be the best method for evaluating dehydration risk in older adults. Long, Rickenbrode and Thibodeaux (2013) describes how a five phase process to improve hydration in care home residents was not only successful in achieving the initial goals, but also improved resident satisfaction and brought various members of the team to work together.

Techniques to identify and measure dehydration

Three ways of assessing fluid balance and hydration status highlighted in the literature are: clinical assessment including body weight and urine output; review of fluid balance charts; and review of blood chemistry.

Nazarko (2007) outlined key observations nurses can make to assess the fluid intake of older people and check whether they have become dehydrated, a year later Docherty (2008) also described the components of a physical assessment needed to determine if a resident is hydrated. Later in 2011 Shepherd also described the elements of clinical assessment including observations, skin elasticity, body weight and capillary refill time. Shepherd's practical discussion (2011) of the importance of hydration and the health implications of dehydration and over hydration provides an overview of fluid balance, including how and why it should be measured, and discusses the importance of accurate fluid balance measurements. Shepherd (2011) also outlines the use of urine output as a measure of hydration. Previously Menten, Wakefield & Culp (2006) tested the associations between urine colour and urine specific gravity to determine whether urine colour, as measured by a colour chart, might be a valid indicator of hydration status in frail nursing home residents. This is a descriptive correlational study of 98 nursing home residents (with adequate renal function) in seven nursing homes in eastern Iowa. Weekly urine specimens were collected and the results averaged over several individual readings and this was found to be a useful tool in assessing hydration status within the limitations of the study. This work has been developed, for example, a subsequent study by Menten and Wang (2011) evaluated the

ability of the Dehydration Risk Appraisal Checklist (DRAC) to measure dehydration risk in nursing home (NH) residents. The DRAC includes items concerning health conditions, medications, fluid intake behaviours, and laboratory abnormalities that have been identified in the literature as risk factors for dehydration. Group comparisons and multiple logistic regression were used to evaluate the criterion-related validity and reliability of the DRAC. The analysis demonstrated that NH residents with higher urine-specific gravity scored higher than those who had lower specific gravity. The authors suggest that, with further refinement, “the psychometric properties of the DRAC indicate that it has potential in determining dehydration risk in NH residents.”

While monitoring fluid balance may be viewed as a simple task, fluid balance recording is notorious for being inadequately or inaccurately completed (Bennett, 2010). A study by Reid (2004), which audited the completion of fluid balance charts on different wards, found the major reasons fluid balance charts were not completed appropriately were staff shortages, lack of training, and lack of time. Shepherd (2011) also gives examples of poorly completed charts. In terms of good practice, Bennett (2010) developed an ‘at a glance’ fluid balance bar chart available here

http://www.institute.nhs.uk/index.php?option=com_mtree&task=viewlink&link_id=3155&Itemid=4930

Several studies (Allison, Ray-Lewis, Liedtke, Buchmeyer & Frank, 2005; Roesler, Lehmann, Krausse, Wirth & von Rentein-Kruse, 2010; Goldberg et al., 2014) have addressed the need for a non-invasive and easily administered ways of documenting fluid imbalance in older adults. Allison *et al.* (2005) measured total body resistance in long-term care facility residents using pairs of electrocardiographs to detect variation of the resistance to the signal as a function of ionic conduction through the electrolyte content of body fluids. The study of 1225 patients (mean age 76 years) found that such measurements correlated inversely with total body water and fluid compartments and concluded that using non-invasive bedside measurements, may offer a definitive guideline for management of adequate fluid balance. The study by Roesler *et al.* (2010) comparing bioelectrical impedance analysis (BIA) and clinical ratings between home and hospital settings had mixed results. However a recent pilot study (Goldberg et al., 2014) investigating the contribution of bioelectrical impedance analysis to measure hydration in 19 older women in residential care and found useful preliminary results and concluded that “if results are confirmed through continued investigation, such findings may suggest that long-term care facilities are unique environments in which all older residents can be considered at-risk for dehydration and support the use of BIA as a non-invasive tool to assess and monitor their hydration status.”

Organisational and staffing issues

Jackson’s vivid description of the hydration cart (2005) acknowledges the time consuming nature of in-between meal hydration activities and need for staff training to ensure correct aids are used for individuals, therefore there must be support for hydration practices throughout the organisation as it is not possible to take a ‘one size fits all’ approach.

The relationship between inadequate nursing home staffing and ‘the silent epidemic of malnutrition and dehydration in nursing home residents’ was reported by Shipman and Hooten (2007) and researched by Dyck (2007). Dyck’s study examined the relationships between nursing staffing and the nursing home resident outcomes of weight loss and

dehydration. The analysis clearly showed that nursing assistant staffing impacted on the quality outcome of weight loss: residents receiving at least 3 hours per day of nursing assistant care had a 17% decreased likelihood of weight loss.

This issue is usefully informed by Mentes' typology (2006) of oral hydration problems exhibited by frail nursing home residents that was developed during a six-month observational study of 35 nursing home residents to assess problems with hydration and to evaluate the presence of dehydration. Urine specific gravity and colour, bio impedance measurements, meal intake recordings, and chart abstraction were used to assess hydration status. Field notes and informal staff interviews were used to describe specific hydration problems and clinically relevant interventions. Dehydration events occurred in a third of the residents during the 6-month period. A typology of hydration problems was developed consisting of four groups (Can Drink, Can't Drink, Won't Drink, End of Life) and six corresponding subgroups. Comparisons revealed the Won't Drink group is most vulnerable to dehydration events because this group has the highest percentage of dehydration events, the highest average specific gravity, and the lowest consumption of fluids during meals. Nursing interventions for the subgroups are discussed. Mentes proposes targeting nursing interventions to the specific hydration problem exhibited by the resident.

Further work by Mentes, Chang & Morris (2006) examines nursing home staffs' perspectives of the problem of dehydration and asks staff to identify clinically practical interventions to ensure that residents consistently take adequate fluids. Data were collected at four focus groups held in three nursing homes in Los Angeles. The majority of the 28 participants were certified nursing assistants. Three themes emerged focusing on residents' reasons for not drinking, signs and symptoms of dehydration, and strategies for improving hydration in residents. It is interesting to see that staff identify the complexity of providing adequate hydration that was influenced by the resident's relationship with family and nursing home staff and communication between staff members.

Promoting adequate hydration in older people (Holman, Roberts & Nicol, 2005) is part of a series for care professionals and assistants on updating and learning new skills. It considers the importance of maintaining a healthy fluid balance in older people and includes a section on being an effective helper.

In terms of training, MacDonald and Walton (2007) demonstrate the usefulness of accessible 'just-in-time, just-for-you' e-learning programmes for caregivers in long-term care (LTC) facilities. An evaluation of 881 employees revealed learner improvement in pre-post test scores in excess of 10%, suggesting an increase in new and relevant skills and knowledge related eight study topics including nutrition and hydration.

The role of care plans is highlighted in a descriptive study about what nurses do to ensure that older people with dementia have adequate hydration (Ullrich & McCutcheon, 2008). Observational data were collected from 10 care workers and seven residents for the types of behavioural nursing interventions and assistance provided to residents when promoting oral fluid intake. Data were compared with resident-care plans to determine whether what was carried out by care workers was consistent with what was being documented. The results showed that care workers provided a wide variety of behavioural interventions to the residents when promoting oral fluid intake but the resident-care plans did not sufficiently

represent the specific interventions implemented by care workers. The authors conclude that a more rigorous approach is required in defining the specific behavioural interactions practised by care workers and point out that whilst nurses determined the content of care documented in care plans, they were not the predominant implementers of that care. In terms of practice, care plans need to be accurate in terms of the specific nursing actions that respond to the level of assistance required by the resident, both behaviourally and physically: "Care plans should serve a dual purpose and facilitate communication between staff members and provide sufficient flexibility to allow for the contribution of novel ways in which to promote oral fluid intake while also being educative."

An Australian study (Beattie, O'Reilly, Strange, Franklin & Isenring, 2014) assessing how much residential aged care staff members know about the nutritional needs of residents found that while 76% of 76 respondents correctly identified risk factors associated with malnutrition in nursing home residents just 15% exhibited correct knowledge of fluid requirements. Further, while nutritional assessment was considered an important part of practice by 83% of respondents, just 53% indicated that they actually carried out such assessments. Identified barriers included insufficient time to observe residents, being unaware of residents' feeding issues, poor knowledge of nutritional assessments, and unappetising appearance of food served. The authors recommend enhancing staff nutritional awareness and assessment skills through increased attention to both pre-service curricula and on-the-job training.

Conclusion

The broad search strategy retrieved a wide range of literature that included topics out of scope, however a small number of highly relevant articles were found in the available literature including papers that described contemporary practice in UK care home settings and include research studies and examples of innovative practice. Some of the qualitative studies (Kenkmann *et al.*, 2010; Godfrey *et al.*, 2012) draw attention to that hydration practice which supports the individual needs of older people and goes beyond simply ensuring the consumption of adequate fluids. Managing effective hydration is a complex scenario as care home residents are often frail, have impaired communication and cannot accurately communicate their thirst and so depend on staff to maintain their fluid intake. Techniques to identify and measure dehydration are described (Reid 2004; Allison *et al.*, 2005; Menten *et al.*, 2006; Nazarko 2007; Roesler *et al.* 2010; Bennett, 2010; Shepherd 2011; Menten & Wang 2011; Goldberg *et al.*, 2014). Organisational and staffing issues are identified. In terms of methodology it would appear that observation is a useful method of enabling older people in care settings to participate in research (Barnes, Wasielewska, Raiswell, & Drummond, 2013).

The evidence indicates that whilst there is still work to be done in the area of hydration practice in the care home setting, both in terms of data collection and developing practice, there are descriptions and examples of current, innovative practice in the UK that can usefully underpin such work.

3. Objective 2: Exploring the co-designing of the Hydr8 'solution'

Objective two explored the collaborative development of the Hydr8 App and included a focus on the process and acceptability of collaborative working between commissioners, providers and industry.

Ethical considerations

This project was approved by the Faculty of Health and Life Sciences Ethics committee at Northumbria University (Ref number: DHCSteven260914). Ethical clearance was also granted by the North of England Commissioning Support Unit (NECS) on behalf of North Tyneside Clinical Commissioning Group.

Procedure and methods

Individuals were approached to take part in this part of the project by GW. GW gave the individuals a participant information sheet and answered any questions that the individuals had about the study. Participants were given up to seven days to decide if they wished to take part. If the individuals wished to take part in the study, and were happy that their questions had been answered regarding participation in the project, they were asked to complete and sign a consent form. Ethical principles were adhered to throughout, data was anonymised, personal details kept confidential and participants were made aware that they could withdraw from the study at any point. Given the small number of participants all direct quotes used have been vetted to try and ensure individuals cannot be identified.

One-to-one semi-structured interviews lasting up to 45 minutes were carried out in a quiet location allowing for detailed exploration of views and perceptions of experiences. The interviews explored the participants' experiences of working as part of the project, the organisation and processes of working with other stakeholders, a comparison of this project and other projects in which they had worked, and any impact that working with the stakeholders had on their current work, or potential impact on future work.

The use of interviews facilitated respondents in sharing views, perceptions and experiences, while allowing them some control over their level of participation and disclosure (Kvale 1996). Where appropriate issues raised by respondents were followed up during the interview and incorporated into subsequent interviews. Such an approach is common in qualitative research and allows the exploration of previously unidentified areas of importance (Silverman 2000, Kvale 1996).

Participants

A purposive sampling strategy was used to include individuals that were part of the development of the Hydr8 solution. Eight participants, from two stakeholder groups, were involved in the study (

Table 4).

Stakeholder group (ST)	
ST1 6 participants	CCG
ST2 2 participants	Business partner

Table 4: List of participants from stakeholder groups 1& 2

Data analysis

All interviews were transcribed verbatim. The transcripts were analysed electronically using NVIVO 10 software. The transcripts were analysed using thematic analysis (Braun & Clarke, 2006). Braun and Clarke (2006) outline six steps to completing a thematic analysis; familiarising yourself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report (Table 5).

Table 5: Six steps of thematic analysis (Braun and Clarke 2006)

1. Familiarising yourself with the data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes	Checking if the themes work in relation to the coded extracts (level 1) and the entire data set (level 2), generating a thematic 'map' of the analysis.
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract example, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

GW analysed all of the transcripts according to the six steps of thematic analysis and then discussed the data and the codes with the wider research team in order to ensure that the data was rooted in the original transcripts, and represented this original data.

Throughout data analysis principles of Realist Evaluation were drawn upon (Pawson & Tilley, 1997). Realistic Evaluation is an approach which views social reality as complex and multi-layered but proposes that by comparing what works, for whom, and under what circumstances, commonalities and variations across mechanisms and outcomes can be identified, described and explored (Pawson & Tilley, 1997). Realistic evaluation emphasises the role of context, taking into account the different organisational settings, workforce, teams and socio-political issues and holds similarities with illuminative evaluation (Parlett & Hamilton, 1977) and Normalisation Process theory (May, et al., 2009).

Summary

There were two main themes running through the data; collaboration and communication.

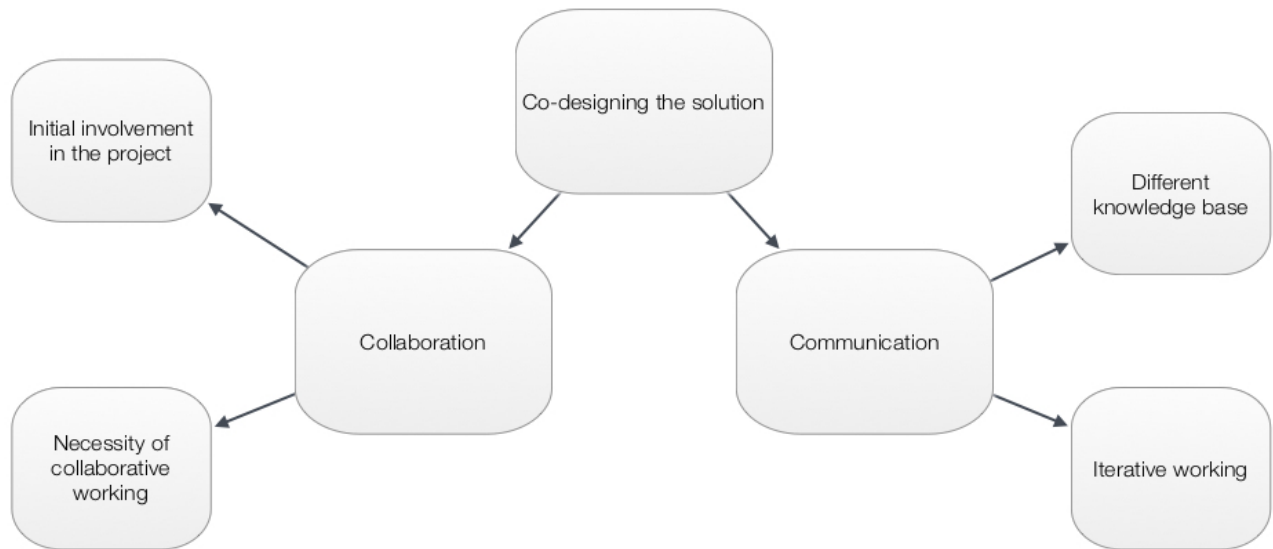
Collaboration encompasses the importance of the involvement of stakeholder groups from the initial conception of the project to develop the solution. This joint development created a team identity between the stakeholders and also increased ownership of the solution for both groups. The perceived necessity of collaboration was also apparent. Individuals from both stakeholder groups understood the importance of each collaborative group in terms of their expert knowledge and skill set. However, there were also perceived drawbacks to working collaboratively, namely time management issues, which some stakeholders felt powerless to change. In addition to the collaboration of both stakeholder groups, the collaboration of the care home managers was also considered essential and perceived as important from the outset in order to improve their feelings of ownership and to maintain engagement in the project.

Communication between stakeholder groups was recognised as imperative given the diverse areas of expertise which needed to come together in developing the solution. Knowledge translation was an essential aspect of collaboration and was successful in part, however, there were some issues that impinged upon the development of the solution. Once more, knowledge translation was not only apparent between the stakeholder groups but also with care home managers. Iterative working was often discussed by both stakeholder groups and was felt to have ensured that both stakeholder groups and care home management were involved throughout the development of the solution. There were however practical difficulties in implementing iterative working, especially in terms of involving care home managers throughout the development process. This resulted in other communication strategies being developed in order to keep all individuals involved in the development process.

Results: Emerging Themes

Two themes emerged, each with sub-themes (Figure 1).

Figure 1: Themes and sub-themes relating to the co-design of the solution



The theme ‘collaboration’ describes the various ways in which the individuals worked together as part of the project, from its initial inception and their attitudes toward the necessity of collaborative working. The theme ‘communication’ encompasses the knowledge and expertise of both stakeholder groups and the necessity to communicate this knowledge continuously and effectively.

Throughout the interviews it was apparent that collaboration not only occurred between two stakeholder groups (stakeholder group one, ST1, and Stakeholder group two, ST2) but also with the ‘end-user’, i.e. care home managers within the North Tyneside area. Although these individuals were not interviewed, there was much discussion about their role within the co-design of solution and this is reflected within the themes.

Given the small sample involved individual participant numbers are not included alongside the quotes in order to maintain anonymity.

1. Collaboration: Initial involvement in the project

There was one aspect of collaboration that was repeatedly discussed throughout the interviews; the participation of both stakeholder groups within the initial development of the project. The project was described as a “*joint venture*” [ST1] and members of ST1 believed that this initial involvement allowed ST2 to feel “*more involved*” and “*part of it*” [ST1]. The development of the project between the two separate stakeholders contributed to the development of a team identity in which individuals from different stakeholder groups felt as though they came together as one team with one common goal.

"I think there's kind of a mini-project team now, and I think it's key that certain members of that project team remain on-board to help make this as successful as it can be" [ST2]

"as a team we started putting this plan together" [ST2].

In addition to enhancing the development of a team identity, the joint development of the project led to greater feelings of the 'ownership' [ST1] of the solution from both stakeholder groups, increasing the involvement in the development process.

"I think they've probably been more involved because we did have that initial involvement, yeah. Because they felt part of it, haven't they? So you've got that greater buy-in." [ST1]

"You know, we've gone above and beyond what we said we would ever do from a commercial perspective, because of the joint venture." [ST2]

The importance of ownership was also acknowledged in its potential to affect the success of the solution's implementation.

"You know, [input from the care homes], that's important if you're looking at ownership, isn't it? In terms of I think everybody knows...Everybody wants it to work. Obviously there's a different vested interest in that. But, having said that, I think by and large, by trying to do that, it's sort of kept people engaged or there or thereabouts" [ST1]

It was felt that the care home management's perceptions of their level of ownership may affect their engagement with the development of the solution.

Both stakeholder groups were involved in the development of the project from the outset and this seemed to influence the way in which they engaged in the project. This process of joint development enhanced feelings of team identity and increased perceived ownership of the solution. Furthermore, the initial involvement of the care homes was seen as pertinent in keeping the care home staff engaged in the development process, and was viewed as influencing the success of the solution's implementation.

Necessity of collaborative working

It was evident that collaboration between stakeholder groups was viewed as essential to the project's success.

"[ST2 are] essential. They're paramount to this being successful." [ST1]

"[The collaboration] was a real opportunity to work differently across the system, a different partnership" [ST1]

"I think, as a business, we have to work collaboratively" [ST2]

The whole premise of ST2 revolved around the necessity of collaborative working, irrespective of the project. A number of reasons were given for the need for collaboration including gaining the necessary 'skill set' [ST1] required to develop the technical solution.

Once more, it was not only the two stakeholder groups who were considered, with the collaboration and engagement of care homes managers also perceived as being essential to the success of the solution.

"We needed to keep the nursing homes engaged. This wasn't just a collaboration between us and the software company. There was another party in that, who was...who was equally important. All three parts of the jigsaw needed to be in place. Because, otherwise, let's be honest, if I was a nursing home I would just disengage." [ST1]

Attitudes towards collaborative working were largely positive and it is apparent that stakeholders thought that collaboration was essential. However, there were drawbacks which caused frustration and influenced attitudes toward collaborative working. One of these drawbacks was the time management issues, which they felt they had little control over as they were dependent on the collaborators.

I think we should have been further down the line [in delivering the solution]
[ST1]

"I just want to see it moving along. With a bit more pace. I think it is taking a bit long if I'm honest, for my liking". [ST1]

One individual specifically stated that they had learned from experiences within this project to "be much more explicit around timelines" when working collaboratively in the future.

Collaborative working was perceived as being an imperative aspect of the success of this project. Working collaboratively enabled the stakeholder groups to engage with each other in the process, as well as the engaging with care home managers and maintaining their interest in the solution. Despite the perceived importance of collaborative working, there were also drawbacks to working collaboratively, namely time management.

2. Communication: Different knowledge base

Members of both stakeholder groups brought different areas of expertise and knowledge. A major advantage of collaborative working is using multiple sets of expertise in developing a solution, process or product. However, efficient knowledge translation is essential in order for all individuals to understand all, or at least some, aspects of the development process. Differences in knowledge, discipline or world view, coupled with technical or discipline specific language has implications and may result in individuals or groups having different understandings, or opinions of the 'solution' being created.

Within this project, individuals from both stakeholder groups expressed their lack of understanding of the others' expertise.

"I don't understand the complexities of all the programming and the databases, because it's not just the app, it's the database it all sits on and uploads...and I don't have any understanding or appreciation of how long that might take" [ST1]

"Some of the terminology that was being used by ST1 and the guys at ST1 was kind of...it was initially lost on me" [ST2]

"When it comes to the clinical side of it, we're not Clinicians...you know, mathematics and theory and, kind of, reason is what we deal in" [ST2]

It was apparent that individuals understood their own lack of knowledge regarding some of the aspects involved in developing the solution. However, not only were they aware of their own lack of knowledge, but individuals also understood that others may lack knowledge about their particular area of expertise. This was often specifically in relation to the language used which was referred to as there often being *"a lot of jargon"* [ST1] or sounding like *"gobbledigook"* [ST2].

Individuals discussed the importance of talking to other stakeholders in order to enhance clinical and technical development, as well as a way of improving understandings of other expertise.

"[The software company] have literally helped us translate what we want from the clinical perspective into an I.T. perspective, so yeah, I think it's worked quite well" [ST1]

"The team at ST1 have articulated their area of specialism really well to my guys...when they've sat down and spoken with [a colleague]...and with the wider team-they've been able to communicate their piece to us. As well as I would hope we could communicate our technical piece back to them. So I don't think there's been any issues whatsoever" [ST2]

In addition to these discussions leading to a heightened understanding of one another's expertise, aiding the development of the solution, it also led to a greater understanding of the importance of the solution for one individual from the software company.

"Being exposed to [clinical] information during the project really helped to understand why we're building this application...it's not just a money making scheme, it's a solution out there to help patients within care homes" [ST2]

For this participant, this knowledge translation shifted the perception of the solution's importance from a monetary value to also being morally valuable. Communication in knowledge translation was important. Individuals continually discussed the communication between the stakeholder groups and it was evident that this was an important part of the development process. However, despite the understanding of the lack of expertise between stakeholder groups, as well as the importance of communication, there were still instances in which knowledge translation was unsuccessful.

"I think what was missing was that I think assumptions were made about how people understand that and how it works in practice. Because people sitting around the table knew. And you assume knowledge, don't you? And I think that is probably why they ended up a wee bit of a blind alley. I think what they really should have done was spend a bit of time at the very beginning just explaining all of that." [ST1]

"I think the biggest frustration is the fact that they...They didn't bank on the Wi-Fi being such a problem" [ST1]

With hindsight, it was perceived that stakeholder groups had not entirely succeeded in translating their own area of expertise to collaborative partners, perhaps due to knowledge assumptions, therefore hindering the development of the solution.

There were apparent differences in the knowledge of both stakeholder groups, leading to continuous knowledge translation throughout the development of the solution. Both stakeholder groups understood their own limitations and the limitations of their collaborative partners. Whereas in some instances, this knowledge translation was deemed successful by the collaborators, there was also some perception that the knowledge translation was ineffective and impacted on the development of the solution.

Iterative working

One aspect that was continually discussed, and was perceived as a highly important part of the collaborative working, was iterative or 'agile' working [ST2], a too-ing and fro-ing back and forth between the stakeholder groups and the care homes.

"The iterative approach- releasing the software every now and then. They can see it, and they get used to it as we release the updates. So it's not a case of we've been hiding under a curtain for months." [ST2]

"Agile development is about...You know, we broadly know what we're building. And we're building it as sprints...And what we do is we release that sprint to...to the client and then they'll test it, check it, make sure it works. And give us feedback on that. And the reason for this is it promotes...It promotes communication between the two parties." [ST2]

This way of iterative working was clearly the working philosophy of ST2 and was also employed within this project. One of its advantages was the possibility of constant feedback from the staff at ST1, shaping the outcome of the solution.

"When you're trying to describe what you want initially, they'll provide something different. So it's not always 100% what you see in your head" [ST1]

"So, for us, working with the iterative approach, encouraging the collaborative working methodology, getting the iterative feedback, helps us throughout because we can adapt and we can change. We respond to change. And that, to us, helps us ensure that what we've got planned next isn't necessarily affected. Because if we release

something at the end of the project schedule and something wasn't right, it has a massive knock-on effect with everything else. So that's the biggest benefit" [ST2]

The constant feedback and development of the solution enabled both stakeholders to have input into its development throughout, as opposed to a scenario where ST2 would have shaped its development alone after only initial discussions. Once more, this agile working was not only between the two stakeholder groups, but also the care home managers who were also able to provide their own input into the development of the solution.

"If we hadn't built up the relationship [with care home managers] and we were saying "right, we're coming to give you something new, something more to do, I think you would have just hit barriers" [ST1]

"We don't understand from the outset the technical capabilities of the care home users....so the design side of it was really important" [ST2]

This allowed the care home managers to get 'on board' with the development of the solution and provide their own knowledge and perspective. However, there were issues with the continuous attendance of care home management due to their busy schedules and which required changes to the way in which the iterative strategy was implemented.

"I mean, obviously, initially they envisaged the care homes being part of a group. And I can understand why that wasn't possible. So we ended up using some of our staff to act as a conduit. Keep going back and forwards saying this is what's happening, what do you think? Which I guess is...sort of, second best. But it's better than not involving people at all. You know, so they're still there in terms of co-production and keeping people up-to-date. But not perhaps actively involved. And I think those are the compromises that you've got to make when you're working with a different provider-all who've got pressing problems, you know" [ST1]

"We went round each of the pilot homes for a bit more in-depth discussion. How should it look?...What do you think? Would your guys be happy to deal with that?...So we did try and do that in every step of the way" [ST1]

Despite the change in strategy to enable care managers to remain engaged with the development of the solution, there were perceived problems.

"From a personal professional's perspective I think it would have been better to have them all round the table all the time because they are not getting that chance to network with each other...they're relying on us to do that and with all of the best will in the world, sometimes we can forget" [ST1]

It is clear that both stakeholders are aware of the importance of care home managers in the iterative working strategy however the way in which they were involved was problematic.

Iterative working was an imperative aspect of the collaboration. It allowed both stakeholder groups to develop the solution together with continuous communication and ongoing

feedback. The involvement of the care homes in this agile working was also imperative but there were practicalities due to time commitments of the management staff involved. In order to remain agile, it was necessary for the stakeholder groups to develop solutions to apply agile working as much as possible.

4. Objective 3: Evaluation of Hydr8 implementation

This study element aimed to describe, explore and evaluate the implementation of the Hydr8 solution in a small number of pilot sites. The study focused the process of implementation and operationalization, embedding and normalisation of the system as part of everyday practice, the impact on care provision and outcomes, and the education, development and training needs of staff.

Ethical considerations

This project was approved by the Faculty of Health and Life Sciences Ethics committee at Northumbria University (Ref number: DHCSteven260914). Participants were informed that they could withdraw from the observations and/or interviews at any point without it having any impact on their employment. Observations were only focused on individuals who had given full, written consent. All written field notes were anonymised and given codes denoting the site and participant number. The observations were focused on interactions with the Hydr8 solution. There were no conversations recorded as part of the field notes. There were no resident/patient details recorded.

The semi-structured interviews were audio-recorded and transcribed verbatim, with all identifying information removed. Case sites and participants were allocated a unique identifier and the key for the ID codes was available only to the research team, and along with the data files which have been kept on a password-protected University server. All transcriptions have been rendered anonymous, i.e. person and place names have been removed and replaced with codes.

Procedure and methods

The owners/CEOs of each care home provider were approached and given an information sheet with details of project and what it would involve for the care home involved. The information sheet included contact details for the research team if the owner/CEO had any questions that they wished to ask. Each owner/CEO was given a consent form and asked to give written consent that they were happy for the care home to be approached and invited to be involved in the project.

Once the owners/CEOs of the care homes had given full, written consent AS and GW met with the management staff of each case site to give them an overview of the study and discuss the process of the project. Participant information sheets and study reply were left for staff in each care home. If members of staff were happy to take part in the study they were asked to indicate this on the study reply slip, along with their name, and place the reply in a box. Staff were assured that were not obliged to take part, and that non-participation would not have any effect on them. The use of a locked box for reply slips ensured that replies remained anonymous to other staff.

After 7 days AS and GW collected the study reply slips after which data collection was organised. When participants were approached to take part in semi-structured interviews they were given an opportunity to re-read the PIS and ask questions about the study before signing a consent form. Participants were made aware that they could withdraw from the study at any point.

One-to-one semi-structured interviews were carried out in a quiet place in the care home. The interviews explored the use of the system in everyday practice, its ease and relevance, perceptions of purpose, worth and value and impact, as well as perceptions of development needs. The use of interviews facilitated respondents in sharing views, perceptions and experiences, while allowing them some control over their level of participation and disclosure (Kvale 1996). Where appropriate issues raised by respondents were followed up during the interview and incorporated into subsequent interviews. Such an approach is common in qualitative research and allows the exploration of previously unidentified areas of importance (Silverman 2000, Kvale 1996).

For the case-study sites only, observations were also conducted with individuals that had consented to take part in the study. AS and GW conducted the observations by locating themselves in a corner of the care home to observe the Hydr8 solution being used. Observations were focused on the use and usability of the system, the normalisation of the system as part of everyday practice, impacts on care provision and outcomes and potential education, development and any perceived training needs of staff. This process of conducting interviews and carrying out observations occurred on two additional occasions at both case-study sites, at approximately two month intervals.

Participants

Data was gathered from five care home sites. Two types of site were included in the evaluation; case study sites (N=2) and interview only sites (N=3). The case study sites (CS1 and CS2) allowed the Hydr8 solution to be monitored over a longer period of time at three separate data collection points. An additional case study site was approached but did not wish to proceed with the study. Observations and interviews were carried out with some of the members of staff on different shifts, over three separate data collection points (Care staff were most commonly interviewed (N=21) as these were the staff who were primarily involved in hydration monitoring, and were therefore the staff who principally used the Hydr8 solution. One registered nurse was interviewed. More nursing staff were sought, but given few nursing staff utilised the Hydr8 solution they felt they had few, if any, experiences to discuss. Five managerial staff were interviewed, as well as one administrative member of staff who oversaw the implementation and use of the back system.

Table 6).

Care staff were most commonly interviewed (N=21) as these were the staff who were primarily involved in hydration monitoring, and were therefore the staff who principally used the Hydr8 solution. One registered nurse was interviewed. More nursing staff were sought, but given few nursing staff utilised the Hydr8 solution they felt they had few, if any, experiences to discuss. Five managerial staff were interviewed, as well as one administrative member of staff who oversaw the implementation and use of the back system.

Table 6 : Data collection by case study site

Case study site 1				
Data collection points	Visit 1	Visit 2	Visit 3	Total
Observations conducted	1	0	0	1
Interviews conducted	4	2	3	9
Case study site 2				
Data collection points	Visit 1	Visit 2	Visit 3	Total
Observations conducted	1	0	0	1
Interviews conducted	4	3	2	9

Despite the intention of observations being conducted at each data collection point, this was not possible as there were various technical difficulties which disabled the use of the Hydr8 solution, therefore the use of the Hydr8 solution could not be observed over the entire period of data collection. In addition to the case study sites, there were three interview only sites included in the evaluation (I1, I2 and I3). Interviews were carried out with some members of staff that were on shift, at one data collection point in each site (see Table 7).

Table 7: Data collection at interview only sites

Interview-only sites				
	Site 1	Site 2	Site 3	Total
Interviews conducted	3	2	5	10

There were a total of 28 participants interviewed across all sites: 18 staff from the case study sites and 10 staff from the interview only sites (see Table 8).

Table 8: Participant numbers by site and type

Occupation	Case study site 1	Case study site 2	Interview site 1	Interview site 2	Interview site 3
Care assistant	7	7	2	1	4
Manager or Assistant Manger	2	1	0	1	1
Administration staff	0	1	0	0	0
Registered nurse	0	0	1	0	0
Total	9	9	3	2	5

Data analysis

All interviews were transcribed into written verbatim text. The observation field notes and interview transcripts were analysed using thematic analysis (Braun & Clarke, 2006) facilitated by the use of NVIVO 10 software. Each member of the research team analysed the transcripts according to the six steps of Thematic Analysis and then discussed the data and the codes with the wider research team in order to ensure that the data was rooted in the original transcripts, and represented this original data. Throughout the data analysis principles of Realist Evaluation were drawn upon (Pawson & Tilley, 1997). Realistic Evaluation is an approach which views social reality as complex and multi-layered but

proposes that by comparing what works, for whom, and under what circumstances, commonalities and variations across mechanisms and outcomes can be identified, described and explored (Pawson & Tilley, 1997). Realistic evaluation emphasises the role of context, taking into account the different organisational settings, workforce, teams and socio-political issues and holds similarities with illuminative evaluation (Parlett & Hamilton, 1977) and Normalisation Process theory (May, et al., 2009).

Results

During visits to undertake interviews where possible the researchers carried out observations, however due to technical issues the Hydr8 solution was not being used on four of the six data collection points. Thus two observations were carried out, one at each case study site and these gave the researchers contextual understandings which helped situate, and make sense of the interview findings. Three main themes were developed from the interview data, each with their own sub-themes; these are shown visually in The theme of 'Care' related to issues (actions, behaviours, knowledge) which constitute or impact upon front line day to day care provision between staff and residents.

The theme of 'Trust' underpinned several aspects of the introduction of the Hydr8 solution and linked not only to the use of technology in care provision but also to staff - management relationships.

'Conditions for long-term use' is a theme which encompasses a series of issues related to the potential of using Hydr8 in the longer term – technical issues encountered, ways around problems and future gazing. Many of these issues were highlighted spontaneously by the interviewees without prompting.

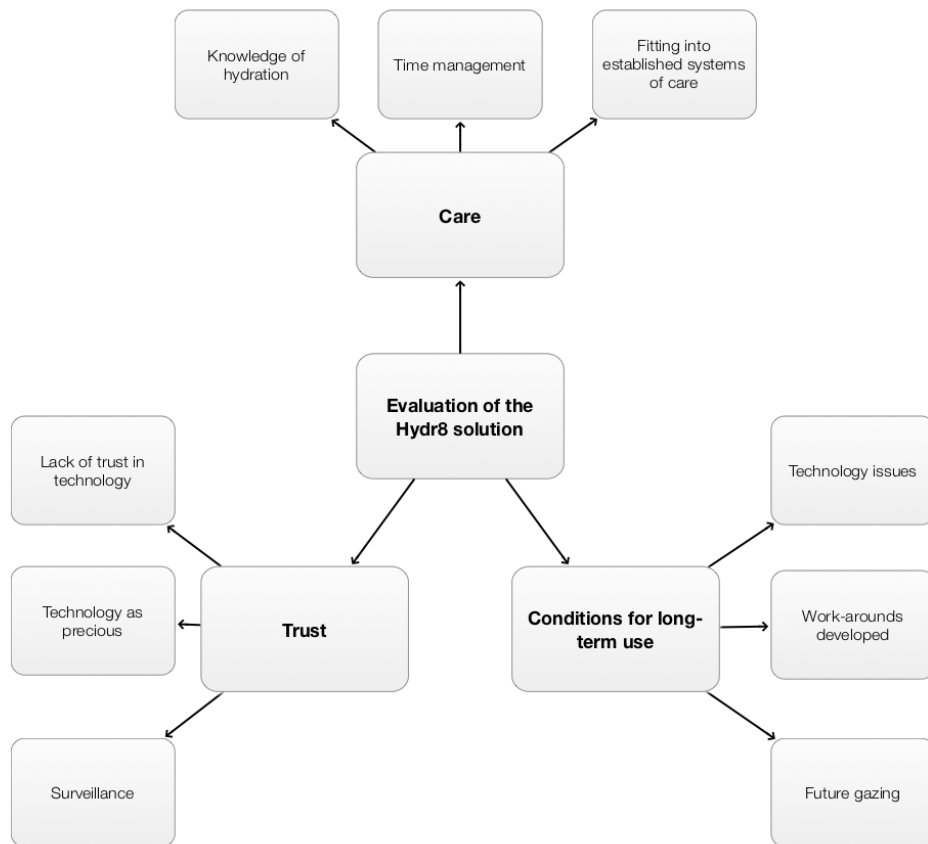
Figure 2.

The theme of 'Care' related to issues (actions, behaviours, knowledge) which constitute or impact upon front line day to day care provision between staff and residents.

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Figure 2: Themes and subthemes relating to the implementation of Hydr8



1. Care

Care: Knowledge of hydration

The Hydr8 app had a positive impact on participants' knowledge and understanding of hydration, however, in some cases also led to heightened anxiety. The visual illustrations of fluid intake on the Hydr8 app enhanced individuals' understanding of hydration, compared to paper-based charts.

"It means less on paper" [P006/CARE ASSISTANT]

"Visually, you can see where it is going up and it makes you feel better knowing that it is going up, you know, because you can give someone 4 or 5 glasses of water and obviously you'd think they're hydrated but you know it is good, it's good to see" [P010/CARE ASSISTANT]

"It's really good because you know exactly where you are and how hydrated people are" [P024/CARE ASSISTANT]

"It has got the outline of the body and it has got the amounts and it colours in the body as you go. So it is really good. Helpful" [P025/CARE ASSISTANT]

These visual illustrations displayed hydration levels for each resident in a more meaningful way and as a result staff became more aware of contextual conditions that can have an effect on hydration. This changed the way in which they hydrated residents.

"If it is warm, obviously, the staff are aware and I've heard them say, 'it's warm today, we'll get some extra drink outs'. Or juice as opposed to a cup of tea" [P003/MANAGER]

"It is hot and we all know we need extra drinks. But if it was Winter, I would probably think aw well I will just give them half a cup, instead of a full cup, so they don't go over [their target]" [P024/CARE ASSISTANT]

Thus Hydr8 seems to have heightened understanding of hydration and impacted on the way that participants hydrate residents. Finally, using Hydr8 also heightened participants' understanding of individual differences in hydration practice.

"You can put their likes and dislikes if, like, they would prefer a drink" [P001/CARE ASSISTANT]"

"It's quite interesting for the carers to see that certain residents need more fluids, and other residents need less" [P003/MANAGER]

"If you're looking on the app you can think 'oh-well actually...he didn't drink that one, he could do with a bit more'. So you are pushing fluids with that particular person, you know. But you wouldn't if it was on paper because you wouldn't realise, but now that it is visual, giving you the push, you know" [P025/CARE ASSISTANT]

The individual differences of residents were highlighted when using the Hydr8 app, compared to the paper-based chart. Specifically, the ability to record residents' preferences, the amount of fluids needed, and the amount of fluids consumed in a particular day were further understood when using the Hydr8 solution.

Despite the visual illustrations being beneficial to participants' understanding of hydration, it also caused some anxiety as individuals were worried about over-hydrating residents.

"If, like, you hadn't clicked on [the resident] you only see they were in the red. So then someone would think, 'oh well, they haven't had enough', but according to the app they have had [too much]" [P001/CARE ASSISTANT]

"It frightened me because I think it was 200%- something she was on, on one day. And I thought...I know it's to do with her target, but because she has, like, a feeder cup, it's 200ml each time. And some people are giving her, like, 4. Because she's really thirsty. And that was worrying me, because I didn't know what that meant. And I thought, 'oh...you know, that's way too much for her weight, and that's over her target'. But then other people were saying no, that's fine" [P002/CARE ASSISTANT]

Participants discussed their anxieties related to over-hydrating residents, in terms of the visual representation on the Hydr8 app being unclear and the use of an illustration which

represented a percentage. However, there was often a lack of consideration for the fact that output was not recorded on the app and therefore the representations (visual and percentages) only reflected input - this was in the initial phase in line with current nursing home practice and may change in future developments.

Overall the visual illustrations heightened the participants' understanding of fluid intake. Participants became more aware of contextual conditions that affect hydration management, as well as understanding individual differences in hydration. One flaw or unintended consequence was the increased anxiety for some members of staff due to fear of overhydrating residents, or confusion related to the visual illustration on the Hydr8 app. It is apparent that further hydration education may be beneficial in the care home setting, and further education for the Hydr8 solution upon implementation.

Care: Time management

The use of the Hydr8 app and back solution impinged upon care in that it often took more time to complete than paper-based charts. There were various reasons why time delays occurred, including technical issues, staff-related issues and the completion of paper-based charts in addition to the Hydr8 solution. There were however some individuals who found the Hydr8 app to be quicker.

"It saves you time sitting there writing it. It is one button and you type it in and send it." [P024/CARE ASSISTANT]

"It seemed a lot more quicker than sitting writing down" [P028/CARE ASSISTANT]

Some individuals felt that typing was quicker than writing down the information on the paper-based chart. However, using the Hydr8 app was predominantly viewed as a time-consuming task. The most frequent reason for the time-delays when using the app was the duplication of information on paper-based chart. Whilst the Hydr8 technology was being trialled, most of the care homes (n=4) completed paper-based charts in addition, in order to ensure that there was no risk in losing data. Often individuals were unaware that the duplication of information was a short-term task, whilst Hydr8 was being piloted, therefore, considered the Hydr8 solution as an extra task, rather than a change, and this seemed to influence their perceptions of using it.

"It's just an extra thing to do at the moment. And it would be for a long while, I think" [P004/ASSISTANT MANAGER]

"Because of it being both at once-both the paperwork and the system- then it is a hassle. But doing one or the other, I think, would be great" [P004/ASSISTANT MANAGER]

"They've still expected us to write it down on paper, so it's double the work" [P019/CARE ASSISTANT]

The technical solution was seen as an addition to a demanding workload, rather than a long-term change. Another form of duplication occurring, and once more taking time away from care, was that participants often wrote down information on a scrap piece of paper until they were able to find a tablet and input the information electronically.

"So what we do, I mean I have got it all here, we carry like a little notebook and as we go we write it all on so that we know exactly what they've had" [P010/CARE ASSISTANT]

Writing down information to input into the solution at a later time added additional work into their day. There were also some staff-related time delays when using the technology.

"Because they had lost a couple of hours, and that was a bit annoying, actually...Something so simple as forgetting their password" [P003/MANAGER]

"We are just going downstairs, and logging in, and then coming back and it is taking time for us" [P020/CARE ASSISTANT]

"I went for [the tablet] this morning and I can't find it and I haven't had time to go next door because I don't know [if the tablet is there either]" [P025/CARE ASSISTANT]

Various staff-related problems led to time delays with inputting data into the Hydr8 app, namely password issues and the placement of the tablets around the care home.

A small number of participants considered the Hydr8 solution as saving time, in comparison to the paper-based chart, however others deemed it as time-consuming. Information being duplicated and staff-related problems resulted in participants' spending further time completing the Hydr8 solution and taking time away from other duties.

Care: Fitting into established systems of care

The normalisation of Hydr8 into everyday practice was an important part of its implementation. There were a number of setbacks that impinged upon the embedding of Hydr8 as part of the daily routine, one being the limited number of tablets given to each care home within the pilot project.

"It hasn't been too difficult, but it's meant that they haven't necessarily been able to record at that moment in time, because somebody else has been using it" [P003/MANAGER]

"So it does tend to be one of them carrying it around with them and then the others tend to be running backwards and forwards to them saying 'I need to put this in, I need to put that in' which is why I think we have got this morning where she is going to update it at the end of her shift when she is doing her notes" [P014/MANAGER]

"You need more than one" [P019/CARE ASSISTANT]

Two tablets were allocated to each pilot site, however, more were needed as participants were not always able to input data into Hydr8 when they needed to do so due to tablets being unavailable. This resulted in time spent searching for the tablets, and also potentially influenced the precision of the records.

There was also a lack of perceived flexibility when compared to the paper-based chart. Users perceived that unlike on paper charts, the Hydr8 app did not allow them to amend the time that drinks were recorded as given, therefore drinks were registered as given at the time the information was input rather than the actual time of serving the resident.

"So with the paper, it's, you can put down what's been offered, and then later you can put down what's been consumed after it's happened. But with the tablet, it's got to be once it's consumed, you write it down. Once you record it." [P004/ASSISTANT MANAGER]

"In a perfect situation we would like to be able to record everything as soon as it happened. But we don't ever really get a chance to do that. And it is always a few hours afterwards. And it means that on the system, everyone has had their drinks a few hours after they actually did" [P004/ASSISTANT MANAGER]

"Sometimes we are putting everything after, when we are nearly done. That is why it is in one go. We are not doing it the right way; I think" [P013/CARE ASSISTANT]

"Trying to get the staff to understand that you can't save it all up to the end of the shift and put all of the fluids in, you need to do it as you go along" [P014/CARE ASSISTANT]

The perceived lack of flexibility in data input also had consequences for the accuracy of the records that were input and stored in the system, as rather than making sure to record information on the Hydr8 app at the time of consumption, individuals completed the records later, as they usually would with the paper charts. This skewed the information held in the Hydr8 solution.

A further aspect which impinged upon the integration of Hydr8 into daily routine was the continuous use of paper-based charts for other areas of care. At the pilot phase Hydr8 was focused on fluid input only. The paper charts were not only required to duplicate fluid data for records, but were also required to record output and were additionally used as a food chart for specific residents. This meant that the paper-based chart remained part of their established routine more so than the technology.

"The way our fluid charts work is that they have the food intake on the other side as well. So the sheets we use, even if we're not to use the fluid side, you've still got to go to them every meal time" [P004/ASSISTANT MANAGER]

"We use the fluid charts on paper is to put outputs from catheters. So there's another thing-we would still need to actually have the fluid charts just for those residents" [P004/ASSISTANT MANAGER]

Hydr8 was viewed as an additional component to the paper-based charts which remained part of daily routine. The lack of integration into daily routines was also reflected in staff-related issues which impacted on the use of the technology.

"If we don't know where the chargers are, it is looking for them. We haven't got time" [P008/CARE ASSISTANT]

"Some people are forgetting to put it on charge. I've just noticed there-battery low" [P023/ASSISTANT MANAGER]

Charging the tablet was not integrated into daily routine and often resulted in the Hydr8 app being unavailable for periods of time.

The way in which Hydr8 became part of daily routines was an important part of implementation. However, there were a number of setbacks which influenced the normalisation of Hydr8 namely: the number of tablets available to the care home, the lack of flexibility of input and the continuous use of paper-based charts. This was compounded by a lack of routinisation of charging the tablets which often led to Hydr8 being out of use for periods of time.

2. Trust

Trust: Lack of trust in technology

There was an apparent lack of trust in the technology, generally, as well as a lack of trust that arose from technical difficulties with Hydr8. Participants often compared the reliability of the technology to pen and paper. The lack of trust was not with the Hydr8 solution itself, but technology generally.

"I have said [to the care staff] you must keep it documented and keep proof because we can't rely on computers" [P011/CARE ASSISTANT]

The individual stressed the importance of recording information on paper as technology could not be trusted. There was often concern about where this data was stored and how easy it was for the data to be accessed.

"I don't know where [the information] goes to be honest, that wasn't handed over" [P019/CARE ASSISTANT]

"My concern to them was... 'but how long does it stay in the cloud?' you know, we could have a safeguarding in 5, 6 years' time...will that still be there or will that be lost in the cloud?" [P023/ASSISTANT MANAGER]

Unlike pen-and-paper records, the information produced from the Hydr8 solution was not tangible. This resulted in there being concern about the storage of the information. A lack of trust of the app also arose from the technical difficulties experienced during use.

"I would worry that we stopped the paperwork because if the inspectors came in and asked for evidence, it wouldn't be there at the moment" [P003/MANAGER]

"There have been days where we've had to stop inputting it halfway through the day, but because we've always had the charts-to food and fluid charts-on paper, we've always had that backup" [P004/ASSISTANT MANAGER]

"It is going to cause problems for us, really, if it carries on like that. Because it's going to look like we're not putting...people aren't getting drinks when they are, because with having to wait so long for it to...to function again" [P026/CARE ASSISTANT]

Technical difficulties resulted in concern over electronic records, without the back-up of the paper charts. There was a general lack of trust in technology, compared to pen and paper,

however this lack of trust was heightened in regard to the Hydr8 solution as a result of technical difficulties experienced.

Trust: Technology as precious

Participants often discussed the solution's hardware, i.e. the tablet, as being precious and were concerned that the tablet would be broken or stolen.

"It is safe [in the office]. And they are not cheap to buy, you know what I mean, so it is best to just keep it where it is safe" [P010/CARE ASSISTANT]

"We can't put it in our pocket especially because if we knock into the hoist or anything like that it is going to break" [P011/CARE ASSISTANT]

"If it gets stolen or broken or anything, we are going to get it in the neck" [P011/CARE ASSISTANT]

The way in which individuals considered the tablet as precious altered the way that they used the Hydr8 solution. Individuals were cautious of carrying the tablets, whilst taking part in other tasks, in case it got broken, however, they were also cautious of putting the tablet down, in case it was stolen.

"We can leave it in the lounge, or we can take it to the dining room but upstairs can't [as someone may take it]. So you have to keep putting it away, keep locking it away, and then you've got to go and get it out" [P008/CARE ASSISTANT]

"We could actually take it around and fill it out, and what we could do is hand it over at the end of the shift to keep us covered so if it was to go missing I could say that I handed it back in, so that is what we have been doing with this" [P011/CARE ASSISTANT]

Whereas when using paper, the participants were able to *"just put the paper down"* [P008/CARE ASSISTANT] they were conscious of the potential consequences of using the tablet in the same way. The concerns about the tablet altered the way in which individuals inputted hydration data as individuals were conscious of the tablet and therefore used the tablet in a different way to the paper-based charts.

Trust: Surveillance

The Hydr8 solution immediately heightened individual accountability of hydration management. Care staff and management staff both considered their own accountability of hydration practice. Staff were apprehensive about the understanding of external agencies towards the solution.

"I wonder how much CQC understand about it, and the local authority" [P003/MANAGER]

"I think it is important that those external assessors and inspectors know about it" [P003/MANAGER]

"When CQC come in, they do go through paperwork and bits and I don't know how they are going to react with having to go through this"
[P011/CARE ASSISTANT]

"From the point of CQC, CCG or local authority coming in and asking for a person's records I don't know how easy it is going to be to get them off here because I haven't seen that side of it yet"
[P014/CARE ASSISTANT]

The accountability of hydration practice to external agencies was continually discussed and individuals worried about their understanding of the Hydr8 solution. Participants were also often anxious of the way in which the data itself was presented to management or external agencies.

"it looks like we flooded them" [P011/CARE ASSISTANT]

"it looks like everybody has had 1000ml rather than drinks all day"
[P012/CARE ASSISTANT]

"It's going to cause problems for us really, if it carries on like that...because it is going to look like we are not putting [drinks] in"
[P026/CARE ASSISTANT]

Individuals were cautious of what the data 'looks like' to others, whether this is due to multiple drinks being inputted in one go or lack of data input due to technical difficulties. It was evident that care staff were also aware of the additional surveillance that the Hydr8 solution presented.

"[Recording the drinks in the Hydr8 solution] is just to prove that you are doing it" [P013/CARE ASSISTANT]

"We could get in trouble [if it is not recorded properly]" [P026/CARE ASSISTANT]

"[The manager] can keep an eye on it as well. So if, like, someone has missed a drink or something...he can come up straightaway and say, 'look, why hasn't this one had a drink for 3, 4 hours?'"
[P026/CARE ASSISTANT]

Despite the heightened awareness of care home staff, the accountability aspect of the Hydr8 solution was seen as beneficial to management staff. Hydr8 was viewed as beneficial in that it records the identification of the user.

"Having that accountability is important" [P003/MANAGER]

"While it is not a blame issue at the moment, if there are certain carers who aren't functioning very well and don't see it as a huge responsibility that it is, then we would obviously need to know who wasn't inputting" [P003/MANAGER]

"Obviously I could go in and look and see who had given them their fluids and who hadn't, erm, match up the rotas and see, you know, who had not been doing fluids on a daily basis"
[P023/ASSISTANT MANAGER]

"You know, I can sit on my laptop when I'm at home, the kids running around, and just check. You know, the night staff are involved in it obviously – I can ring through the night and say, 'you're not giving the residents drinks'. 'We are'. 'Well you're not recording it'. 'We are'. [They're] lying. You know...so it works" [P026/CARE ASSISTANT]

For management Hydr8 was beneficial in that it offered a mechanism which assisted in heightening care staff accountability. Despite some concerns regarding monitoring by external agencies, management staff felt that the accountability and surveillance functions were advantageous. It was also perceived that the Hydr8 solution produced more objective information than paper-based charts. One of the most significant benefits was the ease of monitoring residents' hydration over specific time periods (e.g. a number of days), rather than focusing on only one 24-hour period.

Participants discussed the heightened surveillance that Hydr8 provides as both beneficial and problematic. Management found the accountability aspect of the data input to be beneficial, however, care staff were more aware of their own accountability. Furthermore, there were concerns about the understanding that external agencies had of the Hydr8 solution.

3. Conditions for long term use

Conditions for long term use: Technology issues

A number of technical issues, glitches and knock on effects became evident throughout data collection. These issues impinged upon the implementation of Hydr8 and were evident both in the interviews, from observations made during data collection, and from ad-hoc conversations. The technical issues experienced had an impact on the participants' trust in the technology; their beliefs regarding their own accountability (as discussed above) and their views and opinions regarding the entire Hydr8 solution.

"In theory it's brilliant and I think once they get all of these little hiccups sorted out..." [P003/MANAGER]

There were Wi-Fi connectivity problems experienced throughout the various care homes. Before the Hydr8 solution was implemented in the care homes, connectivity boosters were fitted in the care homes with limited Wi-Fi, however, some care homes still experienced issues.

"[The problem] is the connection. It is just crap [laughs] [P006/CARE ASSISTANT]

"It freezes, it skips, it jumps, it doesn't load. The Wi-Fi connection keeps coming off and doesn't connect back up to the Wi-Fi" [P011/CARE ASSISTANT]

"The internet connection-it used to go off in certain places" [P019/CARE ASSISTANT]

"We use it upstairs, but the problem is through the [Wi-Fi] signal, we cannot get a signal upstairs" [P020/CARE ASSISTANT]

There were often areas of the care homes that could not receive Wi-Fi, or connection would drop whilst the individual was using the app. This had consequences for the way in which the hydration data was recorded as often the data could not be entered at the same time as the drink was consumed. Thus recordings needed to be completed at a later time.

A further technical issue, potentially related to Wi-Fi connectivity, was that the app was often found to run very 'slowly' both when information was recorded and when the app was loading information.

"It has gradually got slower" [P004/ASSISTANT MANAGER]

"Well its generally quite slow, it takes a lot to load up the erm...the patients" [P010/CARE ASSISTANT]

"I sat up here and it took me 20 minutes to put two people in because it was flicking, it was terrible, and I was sitting watching the thing going round and round and round and round and round" [P011/CARE ASSISTANT]

The technical faults led to time being spent away from other duties and increased staff frustration. In addition to being slow, the Hydr8 app repeatedly 'crashed' and 'froze' which resulted in care homes not being able to use the solution for long periods of time. This was witnessed during the observations of case-study sites as only two of the six observations were able to be completed, due to the system 'crashing' and therefore not being in use.

"There's been a few times where it just crashes and it has been saying, unfortunately Hydr8 has stopped" [P004/ASSISTANT MANAGER]

The [tablet] upstairs is not working [P015/CARE ASSISTANT]

"We have been having a problem with, like, getting it all inputted because it would freeze on us" [P024/CARE ASSISTANT]

"Well, at first it was great but then the tablet started to freeze" [P026/CARE ASSISTANT]

Various technical issues led to problems using the Hydr8 solution, namely connectivity issues, the device taking too much time to load information and repeated crashing of the system. This influenced the amount of data that could be entered into the Hydr8 solution and the accuracy of this data, as well as affecting participants' perceptions of the Hydr8 solution and its use in the long-term.

Conditions for long-term use: Work-arounds

Due to technical difficulties and usability issues it was necessary to develop other ways of working with the technology in order for it to remain functional. These 'work-arounds' were developed in-house, or suggested by stakeholders. One of the main technical issues users encountered was the repeated 'crashing' however a solution was developed which enabled continued working

"What we found we had to do was come off the Wi-Fi and then go back into the Wi-Fi once the information had been put into the app so we could re-boot" [P003/MANAGER]

This work-around suggested by the Stakeholders, entailed turning the Wi-Fi off whilst using the device (and app), and turning it on intermittently to connect it to the back room computer and upload the information. Although this worked in many cases, it meant that an extra step was needed by individuals, and this was something else for them to think about and which needed to become a part of their daily routine.

"It's an extra step isn't it? It's just something else more complicated to do" [P004/ASSISTANT MANAGER]

"It's just remembering to [turn the Wi-Fi on], that's it. If we all get used to it, aha, yeah" [P012/CARE ASSISTANT]

There were also various issues with logging on to Hydr8; some individuals could not log on while others forgot their passwords. This led to further work-arounds being developed in-house.

"I was having to give most of the people who were on my email and my password and all logging in and leaving it on for other people to use. Because they couldn't get on to theirs" [P019/CARE ASSISTANT]

However, this was also problematic as it reduced the accountability of individuals. One site specifically stated that they had developed their own additional work around to overcome this which entailed users beginning by "put[ting] their initials in the comments box" [P011/CARE ASSISTANT] to acknowledge that they are the ones that had completed it.

Due to technical problems and usability issues, it was necessary to develop work-arounds to ensure the Hydr8 solution remained functional. However, these sometimes caused additional issues necessitating completion of further tasks.

Conditions for long-term use: Future gazing

Individuals often expressed the inevitability of technology as being part of their job role.

"It's the next, sort of, generation" [P001/CARE ASSISTANT]

"I can see it coming, we are going to end up computerised, I can see it coming" [P014/CARE ASSISTANT]

Various participants specifically expressed their interest in using the Hydr8 solution in the future, however this was based on conditions of use. Technical developments were imperative in perceived long-term use of the solution.

"I mean if it worked, you know, if it worked perfectly..." [P011/CARE ASSISTANT]

"I just think it is a brilliant idea if it all runs smoothly and works" [P016/MANAGER]

"If it was working properly and it wasn't getting stuck, it would be brilliant. So much easier [than paper]" [P026/CARE ASSISTANT]

Individuals considered their use of the Hydr8 solution as being dependent on the elimination of technical setbacks and connectivity issues. Individuals also considered additions to the solution that would be necessary for its long-term use.

"If we had the output too, because we have nowhere to document output, so when we have had loads to drink it looks like we are flooding them [laughs]" [P011/CARE ASSISTANT]

"Food and fluid would be ideal. And I think they would benefit from it because a lot of them are on food and fluid charts. So even though you're getting rid of the fluids, they've still got to go to that chart and do the food." [P023/ASSISTANT MANAGER]

Participants were optimistic and suggested possible additions to the solution, namely fluid output and food charts. Some also considered the improvement of person-centred care through additions to the solution.

"I think it needs to reflect the dementia as well" [P023/ASSISTANT MANAGER]

"We were talking about different areas where they are developing the app. And we did say, like, the end of life stage is something that's...it could be focused on a little bit more" [P027/MANAGER]

"The 24-hour personal care record. Where everything was on one chart, and that saved a lot of time. I think if everything is electronic it's going to be even better. Yeah I really do" [P027/MANAGER]

Some changes to the design of the app were also of importance in long-term use and were repeatedly discussed by participants from across the sample.

"But you can go back [on paper]. With a tablet you can't. Because you go back and put it on, and it's all going to be on at the wrong time" [P001/CARE ASSISTANT]

"They're not editable either. I know they are on the back end, but it means that the carer makes a typing error – there's nothing they can do. And it means you've got to wait until you can speak to a nurse before that typing error can be changed" [P004/ASSISTANT MANAGER]

"If you put a mistake in...you can't delete it, even the nurse was asking me 'how do you delete it?' and we can't delete it" [P011/CARE ASSISTANT MANAGER]

"[It needs to be] as flexible as a piece of paper, you know, because a piece of paper is actually timed out and we can write in what time we gave that drink" [P014/CARE ASSISTANT]

The lack of flexibility with data input was constantly compared to the perceived flexibility of paper-based charts. The rigidity of the solution was discussed in two ways; it was not

possible to delete information that was entered into the app, without going into the back system and it was not possible to edit the time fluids were given to residents.

In addition to changes to the app itself, individuals also suggested changes to the hardware, i.e. the tablet.

“Sharing has been difficult. But we can understand that’s because of cost. But it would have been better to have all of the care staff have their own” [P003/MANAGER]

“But certainly if you had more people on the app and only one tablet it would be problematic. It would be problematic” [P014/CARE ASSISTANT]

The number of tablets in each care home were discussed as problematic throughout the dataset and individuals expressed the necessity of having more tablets in each care home in order to use them long-term.

Individuals perceived the use of technology as an imperative and inevitable part of their job role in the future. Individuals also considered the potential of future use of the Hydr8 solution. Despite some participants being willing to use the Hydr8 solution in the future, it was dependent on various conditions.

5. Final remarks and suggestions

This study had 3 objectives: to review the literature; to explore the development of the Hydr8 solution and evaluate the implementation of the system.

This section will cover final remarks and suggestions related to objectives 2 and 3, the literature review is covered in section 2, (page 9 onwards). However, care must be taken in interpreting the findings and conclusions and not over-generalising from them, as this is a small study that has taken place in one specific geographical location over a limited timeframe.

Collaborative working for development of the solution

There were two main themes running through the data; collaboration and communication.

Collaboration between organisations improves the value of healthcare and increases the likelihood of best-practice care models being recognised and disseminated in an efficient and effective way (Mitchell, et al., 2012). In this project, collaboration through the involvement of both stakeholder groups, beginning at the initial conception of the solution, emerged as extremely important. This joint development created a team identity and led to greater feelings of “ownership” from both stakeholder groups which in turn seemed to increase further involvement in the development process. Thus stakeholder groups felt they came together as one team with one common goal.

Individuals perceived collaboration as a necessity and both stakeholder groups understood the importance of each group in terms of the expert knowledge and skill set they brought to the development process. The stakeholders recognised the project as being in an 'inter-organisational domain' (Trist, 1983) in which one organisation could not tackle the issue alone. However, there were also perceived drawbacks to working collaboratively, for example time management issues were felt to have an impact on working but stakeholders were often powerless to change this. In addition to the collaborative working between the two main stakeholder groups, the collaboration of the care home managers was also considered as being essential. As 'end users', the involvement of care home managers from the outset was considered important in order to engender feelings of ownership towards the Hydr8 solution and facilitate engagement in the project.

The communication between stakeholder groups was recognised as imperative given the different areas of expertise being brought to bear on the process of solution development. Furthermore, open and ongoing communication may be crucial for developing and maintaining understandings of the working style being employed.

Knowledge translation was an essential aspect of collaboration and was successful in part, however, individuals from both stakeholder groups expressed their lack of understanding of the others' expertise and occasional difficulties with the language and jargon used. Sharing information, and understanding barriers are key to successful collaboration, as recognised in studies carried out with health professionals (Elwyn Hocking, Burtonwood, Harry, & Turner 2002; Kvarnstron, 2008). Often, knowledge of individuals' expertise and professions can be undervalued and under acknowledged, impacting on the outcome of the collaboration (Kvarnstron, 2008). However, this example of collaborative working demonstrates success with the dialogue and communication with other stakeholders was recognised as important in enhancing clinical and technical development, as well as being a way of improving understandings of each other's expertise. Knowledge translation endeavours were also apparent between the two main stakeholder groups and the care home managers.

Iterative or 'agile' working was often discussed by both stakeholder and involved a too-ing and fro-ing back and forth between the stakeholder groups and the care homes as the Hydr8 solution was continually developed, allowing developers to respond to change and uncertainty during the development process (Highsmith, 2002). This working style did pose some practical issues in regard to availability of care home management but ways were sought to overcome this and maintain collaboration and feedback.

However, it could be suggested that such a working style, could, if not clearly outlined at the outset and continually reinforced, also have the unintended consequence of prompting frustration in individuals who may expect delivery of fully formed and perfectly functioning solutions. This frustration may indeed be what some of the care staff involved in using the Hydr8 app exhibited.

Notwithstanding the issues and potential for frustration, this style of working had the advantage of offering constant feedback helping shape the resulting Hydr8 solution, and ensured that both stakeholder groups and the care home management were involved throughout the development and felt ownership of the process and product.

Implementing Hydr8 in pilot sites

Three main themes developed from the data analysis: care, trust and conditions for long term use.

Care

The Hydr8 solution had a positive impact on participants' knowledge and understanding of hydration. The visual illustrations, as part of the Hydr8 solution, often heightened the participants' understanding of fluid intake. Care staff reported becoming more aware of contextual conditions that impact on hydration management, as well as understanding individual differences in hydration. Staff's understanding and education of hydration has previously been highlighted as an important aspect of hydration management, and an important method of avoiding dehydration (Abdallah, *et al.* 2009; Ashurst, 2011). However, one unintended consequence of Hydr8 was an increase in anxiety for some care staff due to fear of overhydrating residents, or confusion related to the visual illustration on the Hydr8 solution. Indeed, the levels of hydration illustrated on the app relate to the amount of fluid a person should have during the day (as calculated in line with the policy based on weight, age and any specific health condition) and not how hydrated the body actually is. The data therefore suggests some misunderstandings existed regarding how to interpret the illustration and this indicates a need for enhanced education and training in the future: both regarding hydration in general and the use of the Hydr8 solution in particular.

It was clear however that many staff understood and found the visual illustration on the app reassuring and helpful. The person centred nature of the app showing a picture of the resident alongside their likes and dislikes as well as any choking hazards helped to make a more personal connection between the task of recording fluids given and the impact it has. It was acknowledged that this also helped with new or agency staff as it was more immediate than reading through documentation. The information recorded by Hydr8 reflects the importance of the change in culture of nutrition and hydration practice, with the need to adopt a person-centred approach to care in recording fluid preferences and individual needs (CQC, 2012; Montes, *et al.* 2006).

In comparison to the paper-based charts a small number of participants considered the Hydr8 solution to save time, however others deemed the Hydr8 solution to be time-consuming. Information being duplicated, staff-related issues and the development of 'work-arounds' was sometimes perceived as resulting in participants' spending additional time Hydr8 app, time which could have been spent on other duties.

However, these 'time consuming' issues can be viewed as time limited teething problems, part of the development process and iterative working style previously discussed. Thus it can be postulated that if greater refinement and improvement of the Hydr8 solution is undertaken and these issues resolved, the use of the Hydr8 solution may result in time being saved and staff freed up to perform other duties. This however remains a hypothesis and the implementation of new working practices does not always follow a preconceived logic (Pawson, 2013) therefore further research is necessary to ascertain the consequences, intended and unintended, of the use of a refined Hydr8 system.

The way in which the Hydr8 solution became part of daily routine was an important part of implementation. However, there were a number of setbacks which impinged upon the

normalisation of the Hydr8 solution, namely, the number of tablets available to the care home, the lack of flexibility of input and the continuous use of paper-based charts.

The limited number of tablets given to each care home resulted in staff time spent searching for the devices, and also impacted on the precision of the records. Users were unable to amend the time of drinks given therefore drinks were recorded as given at the point of information input. Thus the lack of flexibility in data input impacted on the accuracy of the records. Re-charging the tablets was not integrated into daily routines and was often forgotten; this led to Hydr8 being unavailable for periods of time.

Trust

There was a general lack of trust in technology, compared to pen and paper, however this lack of trust was heightened for the Hydr8 solution itself because of the technical difficulties encountered. These difficulties also resulted in unease regarding the reliability of electronic records without the back-up of the paper charts, indicating a lack of trust in the system. There were also concerns about where data was stored, how easy the data could be accessed and how long it lasted. It may be that these concerns were heightened by the intangible nature of the records produced, which unlike pen-and-paper records were not physical entities, and a feeling that the data was ephemeral. It appears that trust in the Hydr8 solution needed to be developed over time across the body of staff involved. Concern of trust and privacy of data are not distinct to participants in this study, but are of wider concern across the healthcare system, with the introduction of electronic patient data, or "big data". Furthermore, this situation is perhaps this is akin that of other sectors such as on-line banking or purchasing, where the level of trust of system users is never stable and may require ongoing reassurance to mitigate the fears fuelled by hacking and online data theft. The concern for privacy of data based on the use of cloud-based storage systems is reflected in theories of technology acceptance which are being revised to consider the notion of trust (Alharbi, 2014) based on cloud-based systems.

Participants viewed the hardware (the tablet), as 'precious' and valuable, and were concerned it could be broken or stolen. These perceptions and the comments made indicated (for whatever reasons), that some suspicion and concern existed regarding the people residing in, working in and visiting the homes. Thus there appeared to be a lack of 'complete' trust and a heightened awareness of 'potential consequences' which altered the way that staff used the Hydr8 solution. Pineros-Leano, Tabb, Sears, Meline and Huang (2014) conducted a study with clinic staff using a tablet-based system to carry out depression screenings, and highlighted similar concerns when using the devices. Directly reflecting the findings in this study, participants worried that the device would be lost, stolen or broken during the sessions, and also specifically highlighted the high cost of the devices as being a reason for their concern.

Participants discussed the 'surveillance' that Hydr8 provided as both beneficial and problematic. The use of Hydr8 was immediately seen as heightening individual accountability for hydration management. There was often anxiety about the way data itself was presented, what the data 'looked like' to management or external agencies. There were also concerns from staff and management regarding the understanding that external agencies had of the Hydr8 solution. This anxiety was compounded by the perceived lack of flexibility or accuracy of the data.

However, management perceived the surveillance aspect of Hydr8 (i.e. the recorded timing of hydration and attribution to individual staff members) as beneficial and both staff and managers saw the benefits of being able to see at a glance the hydration levels of the resident over the past few days. This 'over time' monitoring function of residents' hydration levels was perceived as a major advantage over the paper charts.

Conditions for long term use

Various technical issues led to problems using the Hydr8 solution, namely connectivity issues, the device taking too much time to load information and repeated crashing of the system. Wi-Fi connectivity problems and technical faults resulted in time taken away from other duties and staff frustration. Repeated crashing and freezing of the app had consequences for the amount of data that could be inputted into the Hydr8 solution and the accuracy of this data, as well as influencing participants' perceptions of the Hydr8 solution and its use in the long-term.

Due to technical problems and usability issues, staff developed a series of 'work arounds' to ensure the Hydr8 solution remained functional. These included turning the Wi-Fi off whilst using the device, and turning it on intermittently to connect and upload information; several staff logging on using only one person's password. The latter was problematic as it reduced individual accountability thus a further step of putting staff initials in the comments box was introduced. However, these work arounds in turn required users to complete additional tasks thus adding to their workloads.

However various participants expressed their interest and enthusiasm for the use of the Hydr8 solution in the future and saw technology as an inevitable part of their future roles. Despite this willingness to use technological solutions such as Hydr8 in the future, this was dependent on various conditions being met so that any new technology worked seamlessly and efficiently. Participants were optimistic and suggested possible additions to the solution and a number of carers and managers had seen prototypes of fluid output, food and vital signs elements being developed and felt that, providing the issue of WIFI and spooling were addressed, this would make a significant difference to how they worked. Many participants were enthusiastic and saw potential in the Hydr8 solution, as one participant put it,

"If it was working properly and it wasn't getting stuck, it would be brilliant. So much easier [than paper]".

Therefore, although several issues emerged during the implementation of the Hydr8 solution into the pilot care homes it could be suggested that this is congruent both with the collaborative, iterative way of working adopted and the teething problems encountered in the development of any new system.

Suggestions for the future

Commissioning

Consideration needs to be given to working with providers to improve the quality of WIFI connectivity in nursing homes as much of the evolving technology is dependent upon this. This could be included within any new service specification but should recognise the significant financial challenges that many nursing homes have at this time. Nursing homes

should be included in any system wide technology transformation plans enhancing their ability to transfer and receive information that will enhance care delivery.

Research

This study focussed upon one small element of the pilot study and further opportunities should be sought to widen this to possibly include:

- Impact research on using the Hydr8 app in line with the intended objectives of the Hydr8 solution proposal, once fully operational.
- The potential for a Quasi experimental design study to evaluate impact of hydra8 on improved hydration rates and hospital admission
- The addition of a health economic evaluation of the use of the solution
- A more detailed longitudinal research study exploring the normalisation and embedding of Hydr8 into care home working practices

Further research funding should be sought, acknowledging the important platform that the North East AHSN have provided in this pilot.

Education

This study has highlighted the importance of education in relation to managing hydration in nursing homes as part of overall holistic high quality care delivery. It also brings into question the role that some nurses take in ensuring that residents are adequately hydrated and therefore a targeted nurse programme may be useful in some areas. The increasing use of technology means that the workforce needs to be IT literate and opportunities to enhance this need to be explored.

Adopting a collaborative, iterative approach to quality improvement in nursing home practice, such as that used in the Hydr8 project, requires time and further exploration in relation to appropriate education programmes to support this approach. This needs to recognise the pressures that nursing homes are under in relation to workforce challenges and the increasingly complex case mix in many of the nursing homes. Therefore, this should include a clear economic case for ongoing education development and staff engagement.

Policy

This project has shown that working together across the business, commissioning and independent provider's sectors towards a common aim is possible and should pave the way for more collaborative approaches to local policy development.

Practice

The carers and managers in this study were open and honest in their feedback and despite IT difficulties could see the future possibilities and benefits. This has demonstrated that this iterative approach to product development and testing should continue in order to ensure that any subsequent products are fit for practice and will make a difference on the ground for patients and staff.

The technical difficulties with the devices as experienced by care home staff could have been avoided by rigorous testing out with a live environment. Time should be spent with technical partners to ensure that they understand the impacts of errors on care delivery.

Nurse leaders in nursing homes need to take hold of this important quality agenda and ensure that they lead and influence optimum care delivery for the residents they serve.

What's happened since – Ongoing developments

As a result of the project and the evaluation a second pilot is planned by the CCG. This initial pilot study has provided rich insight into the ongoing development and implementation of Hydr8 and its associated development opportunities in order to enhance care provision in nursing homes. The changes arising from practice feedback from stakeholders has resulted in a number of modifications being made which will be piloted in one care home. The care home has been chosen as it has good WIFI connections and all of the devices will be available to the home staff which will help to inform optimum numbers for use and where they are best located. The inclusion of outputs and food intake as well as vital signs and weight has also been considered and are being progressed.

The second pilot will include a standard operating procedure for implementation developed with the home staff so that everyone is clear about the ways of working and what the intended outcomes are in relation to resident and staff benefit. This provides a platform for systematic feedback using a PDSA cycle approach. A targeted education session will also be included particularly for nursing staff who other than in one home have not been actively involved, which itself requires further exploration

Given the nature of the technology it was intended that clinical staff and relatives could be given a log in to view what the individual resident's health status was including hydration, nutritional status, weight, pain etc. and it is intended to continue with this following final testing and system validation.

Study Limitations

It is clear that the study has several limitations which should be acknowledged. The sample sizes and amount of data collected are small and the Hydr8 development and piloting was restricted to a specific geographical area. Therefore, the sample is not representative and care must be taken when extrapolating from the findings as they are not 'generalizable' in a statistical sense but may have some 'transferability' (Seale, 1999). The team that developed the Hydr8 solutions were also involved in providing funding for this evaluation which some may view as a potential bias to the independence of the research team. However, we would argue that all possible measures were taken to maintain distance and independence and to represent all voices as fairly as possible. Although interim findings were fed back to the development team, the design, conduct and interpretation of data were undertaken solely by the research team.

Independent funding for such evaluations is difficult to obtain and similar small scale developments and pilots remain unrecorded and without any form of evaluative research being carried out. We hope that in recording and evaluating this initiative we have added, albeit in a small way, to the existing knowledge base. Furthermore, the project ran for a limited length of time and therefore exploring longer term outcomes and impacts was not possible and would require further research. An economic evaluation would also be a valuable area for consideration in any future work.

Notwithstanding the limitations of this small study the themes emerging from the analysis may have transferability and be of value to others engaged in developing and implementing solutions similar to Hydr8 and have the potential to form the basis for further larger studies.

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Appendices

Appendix 1: Literature review information

Methodology of papers

	Paper	Research Methodology
1	Abdallah, Remington, Houde, Zhan, & Melillo (2009)	Cross-sectional descriptive study used survey findings and focus group interviews
2	Alexander (2008)	Descriptive study evaluated a clinical decision support system
3	Allison, Ray-Lewis, Liedtke, Buchmeyer, & Frank (2005)	Experimental test of using total body resistance measurements using two pairs of electrocardiograph-type electrodes
4	Ashurst (2011)	n/a
5	Barnes, Wasielewska, Raiswell, & Drummond (2013)	Observational study
6	Beattie, et al. (2014)	Questionnaire survey
7	Bennett (2010)	n/a
8	Care Commission (2009)	n/a
9	Care Quality Commission (2011)	n/a
10	Cunneen, Jones, Davidson, & Bannerman (2011)	Cross-sectional observational study (case study) to determine food provision and also food consumption of care home residents. Dietary intake of each participant was recorded and analyzed for a 24 hour period using plate-wastage methodology
11	Docherty (2008)	n/a
12	Dyck (2007)	Descriptive statistics
13	Ellins (2006)	n/a
14	Ferry (2005)	n/a
15	Gaspar (2011)	Comparison of four standards used to determine a recommended water intake among nursing home residents
16	Gleibs, Haslam, Haslam,	Experimental test of the idea of water clubs

	& Jones (2011)	
17	Godfrey, Cloete, Dymond, & Long (2012)	Qualitative study using multiple methods Data were collected via interviews with older people, focus group discussions involving staff, suggestion box comments made by friends and relatives and twelve hours' observation of hydration practice.
18	Goldberg, et al. (2014)	Pilot study investigated the contribution of bioelectrical impedance analysis to measure hydration
19	Hodgkinson, Evans, & Wood (2003)	n/a
20	Holman, Roberts, & Nicol (2005)	n/a
21	Hooper, Bunn, Jimoh, & Fairweather-Tait (2014)	n/a
22	Jackson (2005)	n/a
23	Keller (2006)	Clinical audit tool used was the Joanna Briggs Institute Practical Application of Clinical Evidence System (JBI-PACES) to measure current practice against best practice
24	Kenkmann, et al. (2010)	Exploratory evaluation of changes in food and drink provision: intervention comprising improved dining atmosphere, greater food choice, extended restaurant hours, and readily available snacks and drinks machines was implemented in three care homes. Three control homes maintained their previous system
25	Kreutzer, et al. (2013)	Evaluation of a measurement regarding estimations of filling levels in drinking vessels
26	Long, Rickenbrode & Thibodeaux (2013)	n/a
27	MacDonald & Walton (2007)	n/a
28	McIntyre, et al (2012)	n/a
29	Mentes (2000)	n/a
30	Mentes & Culp (2003)	Quasi-experimental treatment and control group design with 49 participants from four nursing homes to test the effectiveness of an 8-week hydration intervention in reducing hydration-linked events

31	Mentes, Wakefield, & Culp (2006)	Descriptive correlational study (urine colour chart)
32	Mentes (2006)	Prospective observational study,
33	Mentes, Chang & Morris (2006)	Focus groups
34	Mentes & Wang (2011)	Descriptive research, instrument validation
35	Mentes (2013)	n/a
36	Nazarko (2007)	n/a
37	Reed, Zimmerman, Sloane, Williams, & Boustani (2005)	Descriptive, observation
38	Reid, et al. (2004)	Mixed methods: survey, observation, audit
39	Riley-Smith (2013)	n/a
40	Roesler, Lehmann, Krausse, Wirth, & von Rentein-Kruse (2010)	Comparison of clinical judgement and BIA measurements
41	Shepherd (2011)	n/a
42	Shepherd (2013)	n/a
43	Shipman & Hooten (2007)	n/a
44	Sullivan Jr (2005)	n/a
45	Ullrich & McCutcheon (2008)	Descriptive observational study. Ten care workers and seven residents were observed for the types of behavioural nursing interventions and assistance provided to residents when promoting oral fluid intake. Observational data were compared with resident-care plans to determine whether what was carried out by care workers was consistent with what was being documented.
46	Water UK (2003)	Survey
47	Wu, Wang, Yeh, Wang, & Yang (2011)	Cross-sectional study: data of demographic characteristics, activities of daily living, and modes of feeding were collected and tested for association with hydration status. Laboratory data on

		hydration status were also collected.
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Study research methods – literature review

Of the 47 papers referred to in the review 25 were research studies. An examination of the methodologies and data collection types using the terminology featured in the papers themselves revealed a very wide range. Using general categories, eleven studies are best described as descriptive. Six studies considered the tools and processes of hydration through comparison and evaluation. There were three clinical studies, three social intervention studies and two mixed methods case studies.

For example, at one end of the spectrum Allison et al (2005) conducted a clinical experimental test of collecting quantitative data using total body resistance measurements using two pairs of electrocardiograph-type electrodes. Similarly, Goldberg et al (2014) undertook a pilot study investigating the contribution of bioelectrical impedance analysis to measure hydration. Roesler (2010) made a comparison of clinical judgement and bio impedance analysis measurements.

There were three intervention studies. Mentes and Culp (2003) carried out a quasi-experimental treatment and control group design with 49 participants from four nursing homes to test the effectiveness of an 8-week hydration intervention in reducing hydration-linked events; an intervention by Kenkmann (2010) comprised improved dining atmosphere, greater food choice, extended restaurant hours, and readily available snacks and drinks machines in three care homes with three control homes that maintained their previous system. Gleibs (2010) introduced a water club (no control site).

Godfrey's qualitative study (2012) used multiple methods. Data were collected via interviews with older people, focus group discussions involving staff, suggestion box comments made by friends and relatives and twelve hours' observation of hydration practice. Cunneen (2011) used a cross-sectional observational study (case study) to determine food provision and also food consumption of care home residents. Dietary intake of each participant was recorded and analyzed for a 24-hour period using plate-wastage methodology.

By far the largest proportion of research, 11 papers were descriptive in nature. This includes 5 studies involving surveys and/or focus groups, ranging from a large national survey of over 800 respondents by the Royal Society for the Promotion of Health (2003) to smaller studies of residents, families and staff (Beattie 2014, Mentes 2006b, Abdallah 2009) and statistical analysis (Dyck 2007). There were five descriptive observational studies (Barnes 2013, Mentes 2006, Ullrich, S. and H. McCutcheon 2008, Reed 2005, Reid 2004). A cross-sectional study by Wu (2011) collected data of demographic characteristics, activities of daily living, modes of feeding and hydration status.

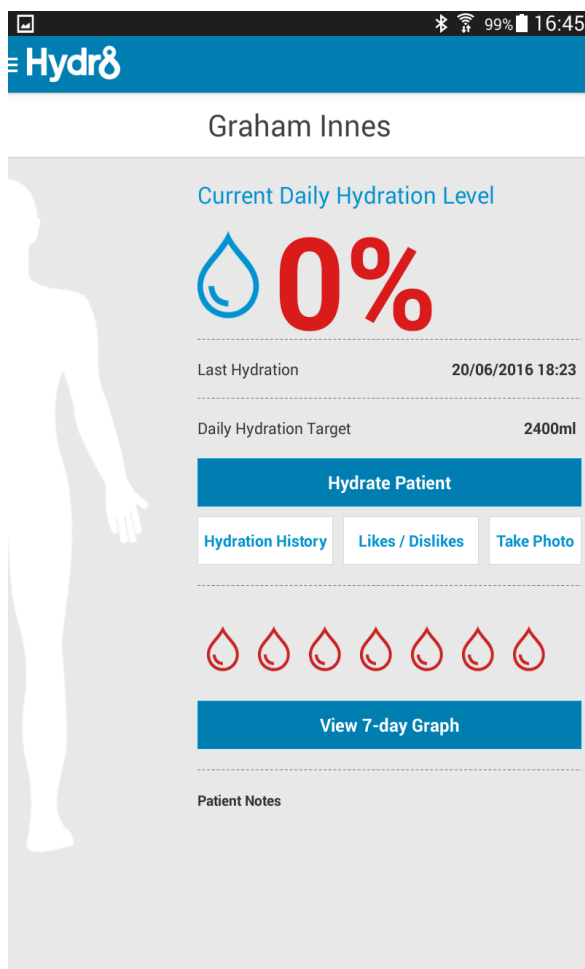
Six studies considered the tools and processes of hydration. For example, Keller (2006) conducted a clinical audit, Alexander (2008) evaluated a clinical decision support system, Mentes and Wang (2011) considered instrument validation, Kreutzer (2013) evaluated a measurement regarding estimations of filling levels in drinking vessels, Mentes (2006a)

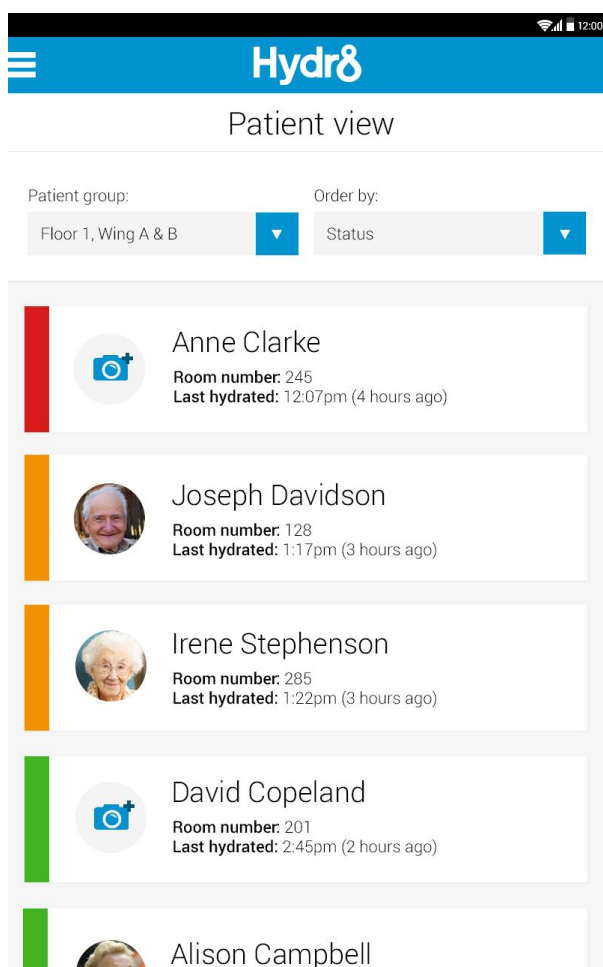
considered the use of a urine color chart, Gasper (2011) compared four standards used to determine a recommended water intake among nursing home residents.

Appendix 2: Images of Hydr8 App

The App itself was intended to act like a “Kanban” or visual signal that someone needed a drink as well as a recording system.

The subsequent changes simply show red and green rather than %





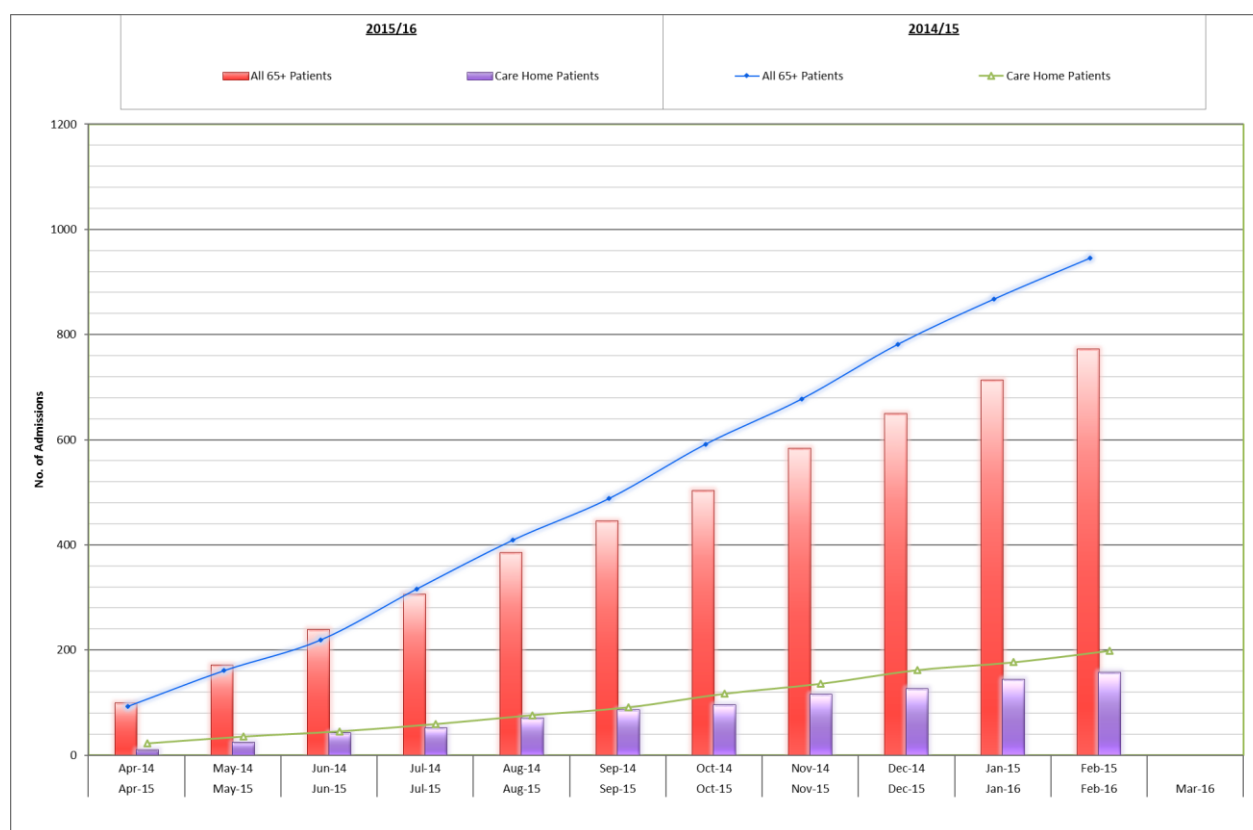
Appendix 3: Routinely collected data

Routinely collected data

The tables below (courtesy of North East Commissioning Support) show the overall figures in relation to hospital admissions where dehydration was an associated feature for all patients over 65, as well as those from care homes. It compares the years 2014/25 and 2015/16 when the Hydr8 app was introduced in pilot care homes. It is important to note that all of the care homes in North Tyneside were involved in developing a common hydration policy and had feedback on quality reviews which may have helped to raise awareness on the importance of hydration.

The charts are intended to provide a context to the pilot project and indicate a downward trend in relation to care home patients. However, given the nature of the study there can be no claim to direct attribution.

Figure 3: Hospital admissions where dehydration was coded 2014-15 vs. 2015-16

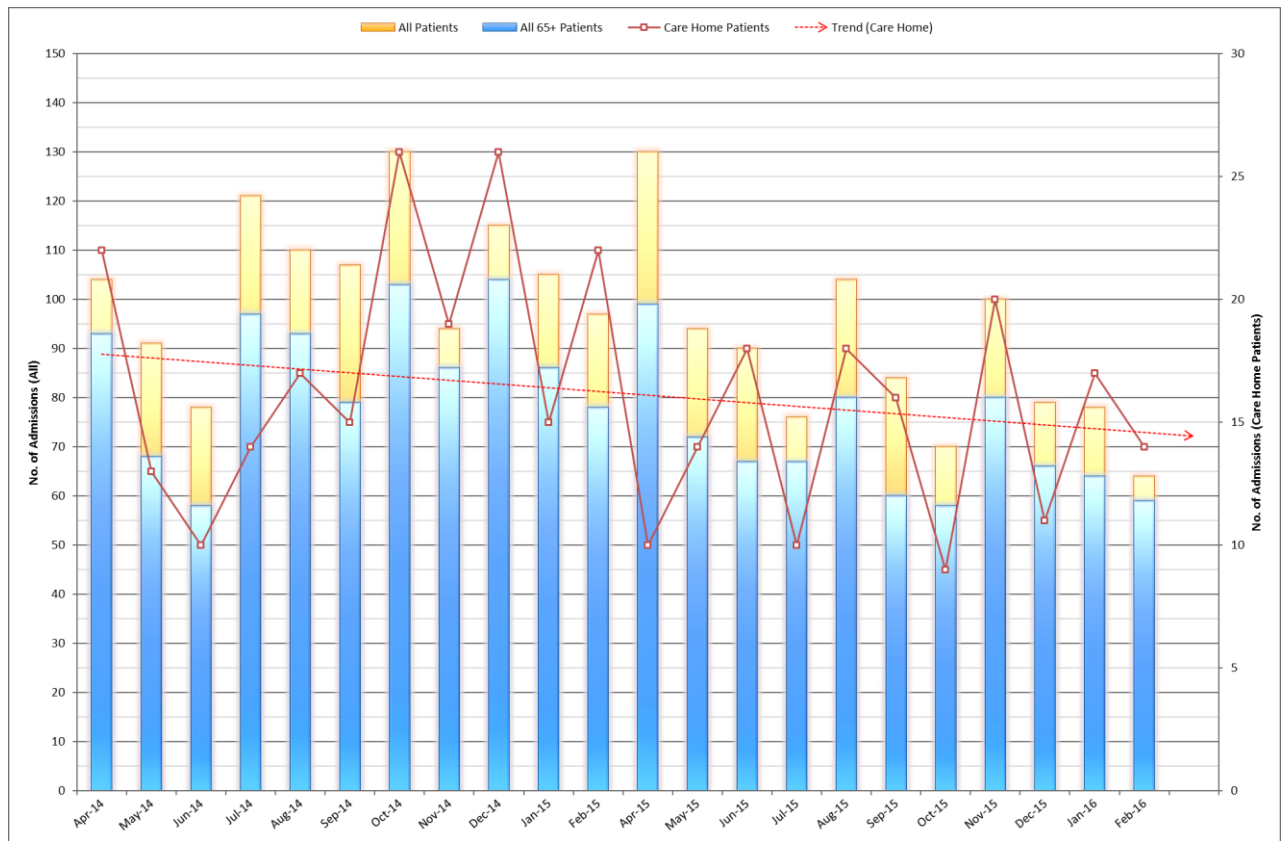


Red columns indicate the years 2015-16 hospital admissions for those over 65 years in age where dehydration was coded, versus the blue line which shows the period 2014-1015. This clearly shows that there has been a decrease in hospital admissions for those over 65 years old, where factors of dehydration are present. However, we cannot make any claims regarding the significance or attribution for this in relation to the implementation of Hydr8.

The purple columns indicate 2015-2016 hospital admissions from individuals of all ages, in care homes only, where dehydration was coded, versus the green line which shows the period 2014-2015. This shows a decrease in hospital admissions for individuals in care homes, where factors of dehydration are present. However, once more, we cannot make any claims regarding the significance or attribution for this in relation to the implementation of Hydr8.

This figure has been included as contextual information.

Figure 4: Month-by-month hospital admissions for patients coded with dehydration



This figure shows hospital admissions for individuals coded with dehydration on a month-by-month basis (April 2014-February 2016). The yellow column shows all patients admitted to hospital and coded with dehydration, irrespective of age (see left axis). The blue column shows all patients over 65, not in a care home, admitted to hospital and coded with dehydration (see left axis). The red line shows care home residents, of all ages, admitted to hospital and coded with dehydration (see right axis).

This figure has been included as contextual information.

